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1 OF 5

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AIR FORCE REPORT
SD TR-79-13
VOLUME III

LEVEL III

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GLOBAL POSITIONING SYSTEMS (GPS)
MANPACK/VEHICULAR USER EQUIPMENT (MVUE)
SET DESCRIPTION
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This report has been reviewed by the Information Office (OIS) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations. This technical report has been reviewed and is approved for publication.

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Director of Navigation Equipment & Avionics
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5.1 RECEIVER CONTROL SUBSYSTEM MODULE DESCRIPTIONS

The following subparagraphs provide module level descriptions for each of the modules which make up the Receiver Control Subsystem.

5.1.1 R1BSN

Mnemonic: R1BSN

Title: Bit Synchronization

Priority: 1 ms

Invoked By: Executive

Invokes: X3STOR, X3WAIR

Inputs:

Parameter	Data Set	Source
Sync Verif. Semaphore	RCNTRL	R2XSMP
Data Clock	N/A	Code Generator

Outputs:

Parameter	Data Set	Destination
Exit Mode Flag	RCNTRL	R3COMM
Data Clock (Div by 20)	N/A	Code Generator

Processing:

R1BSN is executed after a C/A acquisition when an ambiguity exists in the knowledge of where the transition of the data bit may be expected. The transition interval is detected by accumulating

differences between successive 1 ms readings of the data signal over a 20 ms interval for 75 of the 20 ms intervals. That is, the 20 ms interval is partitioned into summations of differences across C/A epochs, S(1) through S(20), each of which represents the sum of 75 differences between 1 ms correlations before and after that particular C/A epoch (note that the data bit transition must occur on a C/A epoch).

Once the summations are accumulated, the transition epoch is identified by a peak search over S(1) to S(20). If the detected maximum, S(i), is less than 1.5 times the previous summation, S(i-1), the transition epoch is identified as S(i-1). The local data clock (divide by 20 of the C/A epoch) is then set to zero at the identified transition epoch.

For Built-in-Test, synchronization verification may be requested. If so, the local data clock is monitored after synchronization has been performed. The epoch in which the data clock is observed to undergo transition is compared against that in which synchronization was performed and an error is generated if they do not match. Possible exit modes are as follows:

Exit Mode Flag	Meaning
-3	Verification failure
-2	Bit sync failure
-1	A/D converter failure
0	Null
1	Bit sync successful

5.1.2 R1CAL

Mnemonic: R1CAL

Title: VCXO Calibration

Priority: 5 ms

Invoked By: Receiver Sequence Controller

Invokes: R3COMM, R3STOP, R3WAIT

Inputs:

Parameter	Data Set	Source
Range Rate Counter	N/A	Output Module

Outputs:

Parameter	Data Set	Destination
FTF Count at Cal.	RICAL	
VCXO Intercept	RICAL	R1SET
VCXO Slope	RICAL	R1SET
Exit Mode Flag	RCNTRL	R3COMM
D/A Converter	N/A	Freq. Synthesizer

Processing:

R1CAL is the task which calibrates the voltage controlled oscillator (VCXO) in the MVUE receiver. Calibration is accomplished in the following manner: the output frequency of the VCXO is measured at each of five input voltages. A least squares linear approximation is generated for these five points. Five voltages are calculated from the original range-rate points, and then compared to the original voltages. If any error exceeds the voltage equivalent of 300 Hz, a second calibration is attempted. If this calibration fails, an error is noted through the exit mode flag and the procedure terminates. Upon successful calibration, the slope and intercept of the approximation along with the FTF time at calibration are output. The exit mode flag may take on the following values:

Exit Mode Flag	Meaning
-1	VCXO calibration failure
0	Null
1	VCXO calibration successful

5.1.3 R1DDT

Mnemonic: R1DDT

Title: Data Detect

Priority: 10 ms

Invoked By: Executive

Invokes: X3STOP, X3WAIT

Inputs:

Parameter	Data Set	Source
Commanded Mode	RCNTRL	R1XCCP
Barker Srch Compl. Cnt	RDATA	R1DDT
State Flag	RDATA	R1DDT, R2PCK
Mode Flag	RKNTRL	R2XSMP
Parity Check Status	RKNTRL	R2PCK

Outputs:

Parameter	Data Set	Destination
Rcvr State Code	RCNTRL	T1BITT
Barker Srch Compl. Cnt	RDATA	R1DDT
Barker Sync Complete	RDATA	R2PCK
Data Ready Flag	RDATA	R2PCK
Message Word Buffer	RDATA	R2PCK
Subframe ID	RDATA	R2PCK
Word Count	RDATA	R2PCK
Truncated Z-count	RDATA	R2PCK
Data Detect Status	RKNTRL	R3COMM
Saved Time Data	RYSAVE	R1RNG
Sync Data	RHSYNC	R1RNG

Processing:

R1DDT checks for transitions in the SV data clock and, depending on the commanded mode of operation, executes direct P-sync, barker code search, or steady-state SV data output. There is also a save-data mode that saves enough information to establish the relationship between system time and GPS time for use by R1PIN in the handover code initialization sequence.

Execution begins on the first half of a 20 ms frame. The SV data

clock is checked for a transition, and if one has occurred, the data bit is transferred into an accumulator. If no clock transition is detected in three consecutive frames, an error indicating a hardware failure is noted and the task terminates.

Based on the value of RDBRKR, one of the three modes is entered following the detected transition. Following C/A acquisition, the data from the satellite is searched for the barker code. If it or its complement is found, the system counters (RHM030, RHM075, and RHZX1) are initialized appropriately. Once the barker code is found, the initial two 30-bit words are passed to R2PCK for verification of frame synchronization. If frame sync is not valid, R2PCK will reset RDBRKR to force R1DDT back into the barker search mode. If 330 consecutive data bits are recovered without a barker code match, then an error is noted and the task terminates. An error is also noted if 4 barker searches are attempted on the save SV without establishing frame sync.

After a successful frame sync, R1DDT is commanded to enter the save-data mode, which is executed once as outlined above. The steady state mode now changes to one in which data from the satellite is output 30 bits at a time to R2PCK, which checks for valid parity and Z-count. During the first 10-ms subframe in each 20-ms period the system counters RHZX1 and RHM075 are updated based on the transitions detected in the present and previous 10-ms subframes.

If direct-P acquisition is attempted, the direct-P sync mode is executed once following the initial detected data clock transition. The system counters are initialized based on the information saved by R1PIN. The following quantities are computed:

15

DELFTF = XC0020 - RY20IN

RHM075 = rem ((RY75IN + DELFTF)/75)

RHZX1 = RYZIN + int((RY75IN + DELFTF)/75)

BITCNT = RHM075 + rem(RHZX1/4) * 75

RDWCNT = int(BITCNT/30) - 1

RHM030 = rem(BITCNT/30)

RDZCNT = int(RHZX1/4)

RDSFID = rem(RDZCNT/5)

Notes: If RDSFID = 0, set RDSFID = 5

If RDWCNT = -1, set RDWCNT = 9

If RDWCNT <> -1, set RDZCNT = RDZCNT + 1

"int" means the quotient from an integer divide operation

"rem" means the remainder from a integer divide operation

Following the counter initialization R1DDT and R2PCK begin normal data recovery procedures.

Errors are reported through the Data Detect/Parity Check status word as follows:

Exit Mode Flag	Meaning
-3	Excess epoch drift
-2	Barker search timeout
-1	Data clock failure
0	Null
1	Subframe count bad
2	Z-count bad
3	Both bad
4	Excessive parity errors
5	HOW recovery
6	Barker search complete (BITE only)

Note: Values 1 through 5 are generated by R2PCK and passed to R3COMM by R1DDT.

5.1.4 R1DSC

Mnemonic: R1DSC

Title: Data Sequence Controller

Priority: 200 ms

Invoked By: Executive

Invokes: M2DBPR, R2PCK, X3WAIT

Inputs:

Parameter	Data Set	Source
Parity Check Mode Flag	RKNTRL	R2XSMP
Generic SV ID	RCNTRL	R1XCCP

Outputs:

Parameter	Data Set	Destination
Data Update Flag	RMSVDT	M2DBPR
Parity Check Start Flag	RKNTRL	R2PCK
Subframe Complete Flag	RMCTRL	M2DBPR
Generic SV Flag	RMSVDT	M2DBPR

Processing:

R1DSC serves as the high level controller for R2PCK and M2DBPR. After initializing flags, a loop is entered which invokes R2PCK and then, if not in a BITE mode, invokes M2DBPR and then waits until the next 200 ms interval.

5.1.5 R1NSE

Mnemonic: R1NSE

Title: Noise Calibration

Priority: 5 ms

Invoked By: Receiver Sequence Controller

Invokes: R3COMM, R3STOP, R3WAIT

Inputs:

Parameter	Data Set	Source
Mode Flag	RCNTRL	R2XSPM
Dwell Time	RSSRCH	R2XSPM

Outputs:

Parameter	Data Set	Destination
Exit Mode Flag	RCNTRL	R3COMM
Noise Calibration	RSSRCH	R1SCH

Processing:

R1NSE measures the average noise level in the MVUE environment in preparation for a sequential search. A noncorrelating code is injected into the narrowband amplifiers prior to the activation of R1NSE. Provision is made to inhibit calibration and substitute a 200 ms delay for AGC stabilization (used for sequences using segmented code searches). The exit mode flag is set upon termination either to -1 to indicate an A/D converter failure or +1 for successful noise calibration.

5.1.6 R1PIN

Mnemonic: R1PIN

Title: P Code Initialization

Priority: 5 ms

Invoked By: Receiver Sequence Controller

Invokes: R3STOP, R3WAIT, X3ERRA

Inputs:

Parameter	Data Set	Source
Range Aiding	RAIDNG	R1XCCP
Precision Time	RJTIME	R1XCCP
SV Acquisition Mode	RCNTRL	R2XSMP
Saved Sync Data	RYSAVE	R1DDT/R1PIN
FTF Count	XCOUNT	X1IT20

Outputs:

Parameter	Data Set	Destination
Code Generator State	N/A	Code Generator
Saved Sync Data	RYSAVE	R1DDT/R1RNG

Processing:

The purpose of R1PIN is to initialize and start the P-code generator in either the direct-P or C/A to P handover mode. This is accomplished after the relationship between the local clock (FTF) and the GPS time has been established. In the direct mode this relationship is defined by the precision time parameters from the Navigation subsystem through R1XCCP: time bias (RJBIA1 and RJBIA2), precision FTF (RJN01 and RJN02), GPS time tag (RJZ01 and RJZ02), and the estimated range to SV (RARNG1 and RARNG2).

In the handover mode analogous parameters are developed within the receiver subsystem by R1DDT: GPS 1.5 Sec Z-count ID (RYZIN), GPS 20 MS Bit Epoch count (RY75IN), corresponding local time ID (RY20IN),

and 5 ms ID (RY5IN).

The processing in R1PIN is concerned with translating this time information into P-code register states valid when the code generator will be started. Since this start will always occur on a 20 ms data bit epoch, the X1A state is 0. The general equations for the states of X1B, X2A, and X2B are as follows:

Let A = number of 10.23 MHz cycles in 20 ms (204600)

B = 20 ms epoch count

Z = 1.5 sec Z-count

then,

X1B = rem (A * B /4093)

X2A = rem ((A * B - 37 *Z)/4092)

X2B = rem ((A * B - 37 *Z)/4093)

where "rem" indicates the remainder from an integer divide.

If the desired starting time coincides with one of the stopped states of any of the P-code registers, the start time is delayed until the following 20 ms epoch.

After all the P-code registers have been initialized the code generator is armed to start. For the handover sequence, a data bit epoch is identified on which the register states are valid. Approximately 10 ms prior to that epoch, the generator is armed to start off the next epoch. For the direct sequence the 5 ms period in which the starting epoch is scheduled to occur is identified. During the preceeding 5 ms period the delayed start count is loaded and the generator is armed to start.

In the direct mode, the precision time information is saved for R1DDT in RY5IN, RY75IN, RY20IN, and RYZIN. R1DDT subsequently

initializes all system counters based on this data. Execution terminates after the code generator is running.

For BITE operation, the 1.5 second X1 code is used. For the L1 test, the X1 code is started 256 counts after the 2nd 5 ms time mark in an FTF interval. The L2 test requires that the P code be started on a 1.5 second X1 epoch in order to maintain synchronization with the BITE module code generator. R1PIN then exits.

5.1.7 R1REG

Mnemonic: R1REG

Title: Linear Regression

Priority: 40 ms

Invoked By: Executive

Invokes: X3WAIT

Inputs:

Parameter	Data Set	Source
Code Phase	RTRACK	R1TRK
Discriminator	RTRACK	R1TRK
40 ms Frame Count	N/A	Executive

Outputs:

Parameter	Data Set	Destination
Regression Data	RFREGD	R1RMO

Processing:

R1REG calculates regression coefficients for R1RMO as follows:

code phase sum	A = SUM(PH)
discriminator sum	B = SUM(DISCR)
sum of code phase and discriminator product	C = SUM(PH*DISCR)
sum of discriminator squared	D = SUM(DISCR**2)
number of data points	N

where:

SUM ::= a summation operation over N points

during a two second interval.

PH ::= code phase from R1TRK

DISCR ::= discriminator calcuated by R1TRK

N ::= number of points received from R1TRK

The sums are accumulated internally over a 2 second interval, then output during the first 40 ms of the next 2 second interval and the internal accumulators are reinitialized to zero.

5.1.8 R1RMO

Mnemonic: R1RMO

Title: Receiver Measurement Output

Priority: 2 second

Invoked By: Executive

Invokes: X3WAIT

Inputs:

Parameter	Data Set	Source
Regression Data	RFREGD	R1REG
Commanded Mode	RBMEAS	R1RNG, R1XCCP
Measured Pseudo-range	RBMEAS	R1RNG
Measured Range Rate	RBMEAS	R1RNG
Aiding Range Rate	RBMEAS	R1RNG
Execute Flag	RBMEAS	R1RNG
SV Pointer	RBMEAS	R1RNG

Outputs:

Parameter	Data Set	Destination
Measurement Data (L1)	RNMEAS	Nav
Measurement Data (L2)	RNIONS	Nav
Measurement Valid. Flag	RMMSGS	M1NSVC, M2STAT
Commanded Mode	RMMSGS	M1NSDT
Receiver Msrment. Parms.	RMZSYA	M1NSDT, M1NS20, M1CNSV

Processing:

R1RMO processes raw pseudo-range, range rate and linear regression data to generate properly scaled and validated measurements for the navigation subsystem. The execute flag, set by R1RNG initiates processing of a measurement. Validity checks on the difference between aiding range rate and measured range rate, as well as the slope of the linear regression computation, are used to verify that the signal was in fact acquired. For a valid measurement, the raw data is scaled and the measured pseudo-range is adjusted by a vernier range computed from

the regression data (slope and intercept of the discriminator output vs. code phase) and the code phase at the time the measurement was made. The measurement outputs are either placed in a 5 by 6 double word array for L1 measurements or a 6 double word vector for L2 measurements.

If BITE is being performed, R1RMO generates the command to perform the L2 test (mode 21) after a successful measurement is obtained at L1. A successful L2 measurement causes R1RMO to report BITE successful (mode 22). A BITE failure (mode 23) is reported if 5 bad measurements are encountered at either L1 or L2.

The following calculations are performed by R1RMO:

Slope of regression line:

```
    (C/N-((A*B)/N**2))*2**16
M = ------------------------
         D/N-(B**2/N**2)
```

Where A, B, C, D and N are calculated by R1REG

Intercept of regression line

Y = (A-MB)/N

Where A, B and N are calculated by R1REG and M is the slope of the regression line calculated above.

Vernier range

VR = RHO(M)-Y

Where PH(M) is the code phase at the time of the range measurement and y is the code phase intercept calculated above

Range rate conversion

RR = 1.040668(COUNT-1.28*10**7)/10

Where count is the raw measurement received from the range rate counter by R1RNG. The units of range rate are 1.040668 m/s LSB.

Pseudo Range Conversion

PR = (C*40920*17+B*17+(A+1)MOD17)

Where A, B and C are components of the range measurement made by R1RNG.

5.1.9 R1RNG

Mnemonic: R1RNG

Title: Ranging

Priority: 5 ms

Invoked By: Receiver Sequence Controller

Invokes: R3STOP, R3WAIT

Inputs:

Parameter	Data Set	Source
Pseudo Range Counter	N/A	Code Generator
Range Rate Counter	N/A	Output Module
FTF Count	XCOUNT	X1IT20
Code Phase at Msrment.	RTRACK	R1TRK
Saved Sync Data	RYSAVE	R1DDT/R1PIN
Commanded Mode	RCNTRL	R1XCCP
SVID Pointer (RTSVID)	RTRACK	R1TRK
Range Rate Aiding	RAIDNG	R1XCCP
C/A or P Indicator	RCNTRL	R2XSMP
S/N Ratio (RPXSNR)	RPHASE	R1TRK
SVID Pointer (RCSVID)	RCNTRL	R1XCCP
S/N Ratio (RMZSNR)	RMZSYN	R1RMO

Outputs:

Parameter	Data Set	Destination
FTF Count	RBMEAS	R1RMO
Code Phase at Msrment.	RBMEAS	R1RMO
Saved Sync Data	RBMEAS	R1RMO
Commanded Mode	RBMEAS	R1RMO
SVID Pointer (RBSVID)	RBMEAS	R1RMO
Range Rate Aiding	RBMEAS	R1RMO
C/A or P Indicator	RBMEAS	R1RMO
S/N Ratio (RBXSNR)	RBMEAS	R1RMO
SVID Pointer (RMASID)	RMASIG	M1CNSV
S/N Ratio (RMASNR)	RMASIG	M1CNSV
Measured Pseudo Range	RBMEAS	R1RMO
Measured Range Rate	RBMEAS	R1RMO

Processing:

R1RNG provides raw measurements of pseudo-range and range rate to R1RMO. Buffering of system data for use by R1RMO and M1CNSV is also

provided.

5.1.10 R1RRM

Mnemonic: R1RRM

Title: Range Rate Measurement

Priority: 5 ms

Invoked By: Receiver Sequence Controller

Invokes: R3COMM, R3STOP, R3WAIT

Inputs:

Parameter	Data Set	Source
Range Rate Counter	N/A	Output Module

Outputs:

Parameter	Data Set	Destination
Measured Range Rate	RAIDNG	R2XSMP
Exit Mode Flag	RCNTRL	R3COMM

Processing:

R1RRM measures the relative range rate of the signal being generated by the Built-in-Test module. The measured range rate is tested for being within the limits +/- 962 counts (1000 m/s). If the test passes, the measurement is output and R1RRM stops; otherwise the exit mode flag is set to -1 and the task communication server in invoked.

5.1.11 R1RSC

Mnemonic: R1RSC

Title: Receiver Sequence Control Kernel

Priority: 5 ms

Invoked By: Executive

Invokes: R2XSIP, R2XSRT, X3WAIT, R2XTEP, R2XSTD

Inputs:

Parameter	Data Set	Source
Queue Control Parameters	REQCPM	R1RSC
Stack Pointer	REQCPM	R1RSC

Outputs:

Parameter	Data Set	Destination
Queue Control Parameters	REQCPM	R1RSC
Stack Pointer	REQCPM	R1RSC
Local Clk (Register 10)	N/A	RSC Subsystem

Processing:

R1RSC performs the kernel function for the Receiver Sequence Control Subsystem. Upon activation, subsystem environment construction services are invoked. Main loop processing is then entered, consisting of four operations: (1) updating of the local clock, (2) readying of tasks activated in the previous time slice for execution, (3) time event processing, and (4) active task processing.

5.1.12 R1SCH

Mnemonic: R1SCH

Title: Sequential Search

Priority: 5 ms.

Invoked By: Receiver Sequence Controller

Invokes: R3COMM, R3WAIT

Inputs:

Parameter	Data Set	Source
Search Parameters	RSSRCH	R2XSPM
Noise Calibration Estimate	RSSRCH	R1NSE (updated by R1SCH)
Commanded Mode	RCNTRL	R1XCCP
Correlation Voltage	N/A	Output Module

Outputs:

Parameter	Data Set	Destination
Noise Calibration Estimate	RSSRCH	R1SCH (update)
Remaining Search Length	RSSRCH	R2XSPM
Exit Mode Flag	RCNTRL	R3COMM
Search Mode	RSSRCH	R2XSPM
Code Phase Adjustments	N/A	Code Generator Module

Processing:

The purpose of R1SCH is to align the locally-generated code (P or C/A) with that being received from the satellite. The program initializes the code generator to the phase corresponding to the beginning of a search bin (a fixed-size group of consecutive code phases), and proceeds to search for phase alignment starting there and retarding the code phase toward the end of the bin until the end of the bin is reached or until alignment is achieved. During this process the ambient noise estimate (RSNSC) is updated at each code phase step.

Initial code phase alignment is acheived whenever the ratio of the correlation to the average ambient noise exceeds 1.35. Alignment

is verified based on the following criteria:

Two counters are used. One, initially zero, counts the total number of measurements taken and the other, initially one, is incremented or decremented as the measurement is above or below the same noise threshold ratio. Success is defined as the second counter reaching 8 or the first reaching 20 before the second reaches 0. A failure is defined as the second counter reaching zero before either of the above conditions occur. If successful, R1SCH leaves the code in such a state that R1TRK can make further adjustments and attempt to close the carrier loop. A failure to verify will cause the process to repeat until either success is achieved or until the search bin is exhausted, at which time failure is indicated and the task terminates. The possible exit modes are as follows:

Exit Mode Flag	Meaning
-3	Search failure, Modes 8, 24
-2	Search failure, other modes
-1	A/D converter failure
0	Null
1	Search successful

The remaining search length and search mode are saved in arrays (one element for each possible generic SV) for use in sequencing modes by R2XSPM.

5.1.13 R1SET

Mnemonic: R1SET

Title: VCXO Set

Priority: 5 ms

Invoked By: Receiver Sequence Controller

Invokes: R3COMM, R3STOP, R3WAIT

Inputs:

Parameter	Data Set	Source
VCXO Slope Intercept	RICAL	R1CAL
Desired VCXO Setting	RAIDNG	R2XSPM

Outputs:

Parameter	Data Set	Destination
Exit Mode Flag	RCNTRL	R3COMM

Processing:

R1SET uses the calibration data generated by R1CAL to set the VCXO to a desired frequency. If the frequency is not achieved within 4 meters per second, another attempt is made, using the calibrated slope and the measured frequency. If four attempts do not succeed, the achieved frequency is checked for within 12 meters per second. If not, an error is reported. If so, R1SET exits normally.

5.1.14 R1TRK

Mnemonic: R1TRK

Title: Code Track

Priority: 5 ms

Invoked By: Receiver Sequence Controller

Invokes: R3COMM, R3WAIT

Inputs:

Parameter	Data Set	Source
Five ms Count (mod 4)	XCOUNT	X1ITO5
Track Mode	RCNTRL	R2XSPM
Inject P Code Flag	RGCATP	R1RMO (reset by R1TRK)
C/A or P Indicator	RCNTRL	R2XSPM
FLL Order Flag	RCNTRL	R2XSPM
Code Peak Search Length	RZCPSD	R2XSPM

Outputs:

Parameter	Data Set	Destination
Code Phase Indicators	RPHASE	R1RNG
Discrim. Value and Phase	RTRACK	R1REG/R1RNG
SVID (RTSVID)	RTRACK	R1RNG
Track Status	RCNTRL	R3COMM
New Discrim. Input Flag	RTRACK	R1REG
C/A or P Indicator	RCNTRL	R1RMO
TRK I Offset	RMZSYN	M1NSDT
S/N Ratio (RPXSNR)	RPHASE	R1RNG
S/N Ratio (RMZSNR)	RMZSYN	M1NSDT
Sum of Maximum and 2nd Highest Correlation	RMZSYN	M1NSDT
Code Peak Search Maximum Correlation Phase	RMZSYN	M1NSDT
Code Peak Search Status	RMZSYN	M1NSDT
A/D Timeout Counters	RMZSYN	M1NSDT

Processing:

R1TRK performs three major functions: a code peak search to align the local replica and satellite codes, coarse centering (Track I) and fine centering and maintaining alignment (Track II).

The code peak search function is optional, being performed on

command (used for steady state operation). It consists of a search, the length of which is specified by R2XSPM, in steps of 16/17ths of a chip with resolution of 8/17ths of a chip. The local code replica is placed at the code phase corresponding to the maximum correlation measurement found during the search. The results of the code peak search are made available to M1NSDT for optional MIS transmission.

The Track I function is a coarse centering operation. Early and late correlation measurements are taken at three code phases surrounding the initial code phase. Four correlation values and three discriminator values result. If the initial code phase was within 8/17ths of a chip, a straight line fit between discriminator measurements is used to center the code. If the initial code phase was within 20/17ths of a chip, the code is set at +/- 12/17ths of a chip from the initial code phase.

The Track II function is the steady state tracking operation and consists of small bumps to keep the code phases aligned. The Track II function also closes the frequency lock loop, phase lock loop, and performs C/A to P handover as requested. A discriminator value is computed at each code phase and passed to R1REG.

5.1.15 R1XCCP

Mnemonic: R1XCCP

Title: Command Communication Processor

Priority: 5 ms

Invoked By: R1RSC

Invokes: R3WAIT, R2XRRP, R2XSSP, R3STOP

Inputs:

Parameter	Data Set	Source
Commanded Mode	MRCOMD	MCSS
Precision Time	NRTIME	N2MAID
Last Commanded Mode	RCNTRL	R1XCCP
Last Generic SVID (RCSVID)	RCNTRL	R1XCCP
Generic SVID (MRCGID)	MRCOMD	MCSS
Aiding Data	NRAID	N2MAID
Static Status	REYRST	R3COMM/R2XSMP
Transient Status	REYRST	R3COMM/R2XSMP
Transient Semaphore	REYRST	R3COMM/R2XSMP

Outputs:

Parameter	Data Set	Destination
Prec. Time (Local Copy)	RJTIME	R1PIN/R2PCK
Comm. Mode (Copy for MIS)	RMMSTA	M1NSDT
Comm. Mode (Local Copy)	RCNTRL	RCSS
Generic SVID (RCSVID)	RCNTRL	RCSS
Bad Measurement Count	RCNTRL	R1RMO
Almanac SVID (RKSVAD)	RKNTRL	R2PCK
Receiver Status	RMMSGS	MCSS
Sequence Spec. Pointer	REQCPM	R2XSSP
Aiding Data (Local Copy)	RAIDING	RCSS

Processing:

R1XCCP serves as the primary interface between the Master Control and Navigation subsystems and the Receiver Sequence Controller. Local copies of interface variables are provided for receiver applications tasks. Command modes from the MCSS are interpreted into process initiations in the RCSS environment via the Sequence Specification

Pointer table processor (R2XSSP). A commanded mode also initiates a receiver reset through R2XRRP.

5.1.16 R1XITM

Mnemonic: R1XITM

Title: Interface Task Monitor

Priority: 5 ms

Invoked By: R1RSC

Invokes: R3COMM

Inputs: None

Outputs: None

Processing:

R1XITM provides communication monitoring of tasks which are not local to the Receiver Sequence Controller and hence may not invoke R3COMM directly. It is activated with a Task Attribute Record specifying the communication structure for its nonlocal counterpart. The interface task monitor then requests communication services each time it is invoked thus invoking associated processes for the nonlocal task. Message Control Blocks of the communication structure are for the interface task monitor.

5.1.17 R2PCK

Mnemonic: R2PCK

Title: Parity Check

Priority: N/A

Invoked By: R1DSC

Invokes: none

Inputs:

Parameter	Data Set	Source
Data Ready Flag	RDATA	R1DDT (reset by R2PCK)
Barker Sync Flag	RDATA	R1DDT (reset by R2PCK)
Look for Subframe Complete Flag	RKNTRL	R1DSC (reset by R2PCK)
SV Data Word	RDATA	R1DDT
Parity Check Mode Flag	RKNTRL	R2XSMP
Parity Check Inhib. Flag	RKNTRL	R2XSMP
Almanac SVID	RKNTRL	R1XCCP
Time since power up	RJTIME	R1XCCP

Outputs:

Parameter	Data Set	Destination
Word Count (Local Copy)	RDATA	R2PCK
Z-count (Local Copy)	RDATA	R2PCK
Subframe ID (Local Copy)	RDATA	R2PCK
Parity Check Status	RKNTRL	R1DDT
Word Count	RMSVDT	M2DBPR
SV Data	RMSVDT	M2DBPR
Data Validity Code	RMSVDT	M2DBPR/M1NS20
Subframes Complete Flag	RKNTRL	R1DSC
Update Flag	RMSVDT	M2DBPR
Almanac SVID	RMSVDT	M1DBPR
Subframe ID	RMSVDT	M2DBPR
Z-count	RHSYNC	R1DDT

Processing:

R2PCK has the responsibility of computing and verifying parity of the data words transmitted from the satellites. In the C/A acquisition mode, R2PCK waits for R1DDT to declare a successful barker search and to pass the HOW and TLM words. Parity is computed on both words and, if good, the recovered Z-count is checked for consistency with the time input by the user (or local FTF if in mode 3). If this test also passes, the HOW data is used to correct the value of RHZX1 initialized by R1DDT, and the subframe counter (RDSFID) and word counter (RDWCNT) are also initialized. If any of the tests fail, R2PCK will notify R1DDT through RDBRKR to resume barker search.

The steady state mode is entered upon completion of frame sync or in direct-P acquisition. R2PCK receives the recovered SV data words from R1DDT once every 600 ms (the received data consists of the last two bits of the preceding word along with the 30 bits of the current word) and computes and verifies parity. The subframe, word count, and Z-count are updated and verified against the received subframe and Z-count. Any disagreement is reported by passing an invalid word count (RDWCNT). The data word is passed to RDMSW1 and RDMSW2, along with the current subframe count (to RDSFID) and word count (to RDWCNT). During the steady state mode, if there are eight consecutive parity failures on the SV data words, Master Control is notified of the problem. R2PCK also checks the Roll-Momentum Dump and SV Sync flags and sets the subframe ID (RDSFID) to an

invalid value if either flag is set.

Parity check is inhibited (RKPCIN = -1) during built-in-test sequences, but the data is still blocked and passed along as usual.

The parity check algorithm is as follows: If the last bit of the preceding word (E30) is '1', the bits d1-d24 are inverted, otherwise left as is. They are then substituted into the parity equations below. If the computed bits D25-D30 match the received D25-D30 then the parity check passes, else a failure is reported.

Following are the ground segment parity encoding equations used in R2PCK:

Equations for words 3-9

D1 = d1*E30
D2 = d2*E30
D3 = d3*E30
. .
. .
. .
D24 = d24*E30

D25 = E29*d1*d2*d3*d5*d6*d10*d11*d12*d13*d14*d17*d18*d20*d23

D26 = E30*d2*d3*d4*d6*d7*d11*d12*d13*d14*d15*d18*d19*d21*d24

D27 = E29*d1*d3*d4*d5*d7*d8*d12*d13*d14*d15*d16*d19*d20*d22

D28 = E30*d2*d4*d5*d6*d8*d9*d13*d14*d15*d16*d17*d20*d21*d23

D29 = E30*d1*d3*d5*d6*d7*d9*d10*d14*d15*d16*d17*d18*d21*d22*d24

D30 = E29*d3*d5*d6*d8*d9*d10*d11*d13*d15*d19*d22*d23*d24

where

d1, d2,....., d22 are the raw data bits

D25,...., D30 are the parity bits and equations

E29, E30 are the last two bits of the previously transmitted word

D1, D2,....., D29, D30 are the bits uploaded by the control segment and are subsequently transmitted by the satellite

'*' indicates the exclusive-OR operation

Equations for words 1, 2, and 10

D1 = d1*E30

D2 = d2*E30

D3 = d3*E30

. .

. .

. .

. .

D22 = d22*E30

D23 = E29*d1*d7*d8*d11*d13*d14*d16*d17*d18*d19*d21

D24 = d1*d3*d5*d6*d7*d9*d10*d14*d15*d16*d17*d18*d21*d22

D25 = E30*d2*d3*d5*d6*d7*d8*d10*d12*d16*d19*d20*d21

D26 = d1*d2*d4*d5*d9*d10*d11*d12*d13*d16*d17*d19*d22

D27 = E29*d1*d3*d4*d5*d7*d8*d12*d13*d14*d15*d16*d19*d20*d22

D28 = E29*d1*d2*d4*d5*d6*d7*d9*d11*d15*d18*d19*d20

D29 = 0

D30 = 0

where

d1, d2,....., d22 are the raw data bits

D23,...., D30 are the parity bits and equations

E29, E30 are the last two bits of the previously transmitted word

D1, D2,....., D29, D30 are the bits uploaded by the control segment and are subsequently transmitted by the satellite

'*' indicates the exclusive-OR operation

5.1.18 R2XCPP

Mnemonic: R2XCPP

Title: Post-Termination Processing Cancellation Service Processor

Priority: N/A

Invoked By: R2XSRT

Invokes: None

Inputs:

Parameter	Data Set	Source
Task Attribute Record Address	N/A	Register 0 of calling program

Outputs:

Parameter	Data Set	Destination
Task Descriptor Block	REUQLS	RSC Subsystem
Post-termination SRT Pointer		R2XSRT

Processing:

R2XCCP permits the deletion of post-termination Service Request Table (SRT) processing from the specified active sequence controller local task. It determines if the specified task is active and, if so, the post-termination SRT pointer of its Task Descriptor Block is zeroed. It is assumed that the task is local. Refer to paragraph 3.1.3.1.3.8 for additional detail.

5.1.19 R2XERR

Mnemonic: R2XERR

Title: X3ERRA Interface Processor

Priority: N/A

Invoked By: R2XSRT

Invokes: X3ERRA

Inputs:

Parameter	Data Set	Source
Data Block Address	N/A	Register 0 of calling program

Outputs:

Parameter	Data Set	Destination
X3ERRA calling parms.	N/A	X3ERRA

Processing:

R2XERR uses the data passed through the service request block to generate a call to X3ERRA. It fetches an error code, argument count and argument addresses and constructs an X3ERRA call using these parameters.

5.1.20 R2XHMP

Mnemonic: R2XHMP

Title: Hardware Modification Processor

Priority: N/A

Invoked By: R2XSRT

Invokes: Modification Control Record

Inputs:

Parameter	Data Set	Source
Pointer to Modification Control Record	N/A	Register 0 of calling program

Outputs: None

Processing:

R2XHMP services receiver hardware control function requests specified in hardware modification service request blocks (SRB's). The SRB provides a pointer to a modification control record (MCR), which is executable code included in the ROM data set REHMCR. Control is transferred to the MCR which performs the control function and executes a return to R2XSRT (control does not return to R2XHMP).

5.1.21 R2XLCS

Mnemonic: R2XLCS

Title: Local Clock Synchronization

Priority: N/A

Invoked By: R2XSMP

Invokes: None

Inputs:

Parameter	Data Set	Source
Executive Time Data	XCOUNT	X1IT20, X1IT05
Local Clock Modulo	REWCTB	ROM Constant

Outputs:

Parameter	Data Set	Destination
Local Clock	REVKWS	RSC subsystem

Processing:

R2XLCS synchronizes the Receiver Sequence Controller local clock with the MVUE executive clock. Time data is obtained from the MVUE 20 and 5 ms counters. The local clock is set to the MVUE Executive time in 5 ms units, modulo the period of the local clock defined in the data set REWCTB.

5.1.22 R2XNOP

Mnemonic: R2XNOP

Title: No Operation Processor

Priority: N/A

Invoked By: R2XSRT

Invokes: none

Inputs:

Parameter	Data Set	Source
Pointer to NOP Service Request Block	N/A	Register 0 of calling program

Outputs: None

Processing:

R2XNOP provides a null service procedure for diagnostic purposes. IT is not invoked in the final software.

5.1.23 R2XRIP

Mnemonic: R2XRIP

Title: Receiver Initialization Processor

Priority: N/A

Invoked By: R2XSMP

Invokes: none

Inputs: none

Outputs:

Parameter	Data Set	Destination
AGC Select Control	N/A	Narrowband Modules
Q Switch Control	N/A	Narrowband Modules
TRANSEC Code Select	N/A	Code Generator Module
T Code Enable	N/A	Code Generator Module

Processing:

R2XRIP provides receiver hardware initialization for certain functions which are not normally changed in the MVUE operation, specifically:

AGC Select Control := Internal

Q Switch Control := Closed

TRANSEC := Not Selected

T Code := Enabled

5.1.24 R2XRRP

Mnemonic: R2XRRP

Title: Receiver Reset Processor

Priority: N/A

Invoked By: R1XCCP

Invokes: R3CANC, R3WAIT

Inputs:

Parameter	Data Set	Source
Commanded Mode	RCNTRL	R1XCCP

Outputs:

Parameter	Data Set	Destination
Active Task Queue	REZATT	RSC Subsystem
Time Event Queue	REQCPM	RSC Subsystem
Parity Chk Status Flags	RKCSFF	R2PCK
Search Paramater Manager Cycle Semaphore	RCNTRL	R2XSPM

Processing:

R2XRRP serves to reinitialize the receiver control subsystem and the receiver hardware when a mode command is received by R1XCCP. The reset consists of the following: (1) suspension of active tasks, (2) purging of the time event queue, (3) cancellation of suspended tasks, (4) resetting of the receiver hardware, (5) resetting of search parameter manager cycle semaphore and (6) resetting of parity check status flags.

5.1.25 R2XSAS

Mnemonic: R2XSAS

Title: Task Activating Service Processor

Priority: N/A

Invoked By: R2XSRT

Invokes: R2XSRT, X3ACT

Inputs:

Parameter	Data Set	Source
Activation Control Block Pointer	N/A	Register 0 of calling program

Outputs:

Parameter	Data Set	Destination
Task Descriptor Block	REVQLS	RSC Subsystem

Processing:

R2XSAS provides activation services for both global and local tasks. The Activation Control Block is fetched, and the pre-activation Service Request Table is processed. Then, if the task is global, an X3ACT call is constructed and executed. If the task is local, a Task Descriptor Block is constructed and appended to the waiting task queue.

5.1.26 R2XSCS

Mnemonic: R2XSCS

Title: Task Cancelling Service Processor

Priority: N/A

Invoked By: R2XSRT

Invokes: R2XSRT, X3CANC

Inputs:

Parameter	Data Set	Source
Task Activation Record Pointer	N/A	Register 0 of calling program

Outputs:

Parameter	Data Set	Destination
Task Descriptor Block	REUQLS	RSC Subsystem

Processing:

R2XSCS provides task cancelling services for both global and local tasks. The current task status is checked and ,if not active, no action is taken. If the task is global, X3CANC is called to cancel the task. If it is local, it is dequeued and the Task Descriptor Block storage is released.

5.1.27 R2XSIP

Mnemonic: R2XSIP

Title: System Initiatialization Processcr

Priority: N/A

Invoked By: R1RSC

Invokes: X3WAIT

Inputs:

Parameter	Data Set	Source
Environment Tables	REETPC	ROM Constants

Outputs:

Parameter	Data Set	Destination
Control Variable Mem.	REQCPM	RSC tasks
Queue, List Stack Mem	REUQLS	RSC tasks
Task Status Table	REQCPM	RSC tasks
Receiver Status Table	REYRST	RSC tasks

Processing:

R2XSIP is invoked by R1RSC at system initiation in order to initialize the Receiver Sequence Controller. Memory is cleared in the areas defined by REE001. Monodirectional linked lists for Task Descriptor Block storage and Time Event Block storage are set up in accordance with REE002. Recursion structures are initialized as specified by REE003.

5.1.28 R2XSMP

Mnemonic: R2XSMP

Title: Software Modification Processor

Priority: N/A

Invoked By: R2XSRT

Invokes: subtasks specified in Service Request Block entry vector pointer, if any

Inputs:

Parameter	Data Set	Source
Pair Transmission Table Pointer	N/A	Register 0 of calling program

Outputs:

Parameter	Data Set	Destination
As specified in pair pointer table	REIPPT	

Processing:

R2XSMP processes software modification requests, which may be specified in a Parameter Pair Pointer table and/or in a subtask. The Service Request Block specifies either or both services. R2XSMP processes the Pair Pointer Table, if one exists, by moving data from source addresses to destination addresses as specified by transmission specification blocks referenced by the Pair Pointer Table. If an Entry Vector Pointer table exists, one or more subtasks are invoked as specified by the Entry Vector Pointer table.

5.1.29 R2XSPM

Mnemonic: R2XSPM

Title: Search Parameter Manager

Priority: N/A

Invoked By: R2XSMP

Invokes: none

Inputs:

Parameter	Data Set	Source
Cycle Semaphore	RCNTRL	R1XCCP/R2XSPM
Almanac SVID (RASVAD)	RAIDNG	R1XCCP
Code Selections	REFCDE	ROM Data Set
Generic SVID (RCSVID)	RCNTRL	R1XCCP
Commanded Mode	RCNTRL	R1XCCP
Aiding Range Rate	RAIDNG	R2XCCP

Outputs:

Parameter	Data Set	Destination
Precision Time Data	RJTIME	R1PIN
Range Aiding	RAIDNG	R1PIN
Search Mode	RSSRCH	R2XSPM
Remaining Search Length	RSSRCH	R2XSPM
Search Parameters	RSSRCH	R1SCH
Doppler Offset	RAIDNG	R1SET
Code Peak Search Length	RZSLTN	R1TRK

Processing:

R2XSPM implements the search strategy for each of the receiver modes. Search parameters (search length and doppler offset) are stored in internal tables except for mode 25 (almanac acquisition) which involves searching the full doppler range (+/- 750 meters per second) if the signal is not acquired at the aided range rate.

5.1.30 R2XSRT

Mnemonic: R2XSRT

Title: Service Request Table Processor

Priority: N/A

Invoked By: R1RSC, R2XSAS, R2XSCS, R2XTEP, R2XSSP, R3COMM

Invokes: R2XHMP, R2XNOP, R2XSAS, R2XSCS, R2XSMP, R2XTES, R2XSSP, R2XCPP, R2XERR

Inputs:

Parameter	Data Set	Source
Service Request Table Pointer	N/A	Register 0 of calling program
R2XSRT Recursion Stack Depth	REWCTB	ROM Constant

Outputs:

Parameter	Data Set	Destination
Service Request Block Pointer	N/A	Register 0 of R2XSRT

Processing:

R2XSRT processes service request table entries. The operation code of each service request is interpreted and the corresponding service request processor is invoked. Recursion is supported to the depth specified in REWCTB.

5.1.31 R2XSSP

Mnemonic: R2XSSP

Title: Sequence Specification Processor

Priority: N/A

Invoked By: R1XCCP, R2XSRT

Invokes: R2XSRT

Inputs:

Parameter	Data Set	Source
Sequence Specification Pointer	REQCPM	R2XSSP, R1XCCP
R2XSSP Recursion Stack Depth	REWCTB	ROM Constant

Outputs:

Parameter	Data Set	Destination
Sequence Specification Pointer	REQCPM	R2XSSP

Processing:

R2XSSP initiates the processing of the next Service Request Table in a System Specification Table. The Service Request Table (SRT) pointer is fetched as specified by the sequence specification pointer. If the SRT pointer is not null, SRT processing is initiated and the sequence specification pointer is advanced. Recursion is supported to the depth specified in REWCTB.

5.1.32 R2XSTD

Mnemonic: R2XSTD

Title: Task Dispatcher

Priority: N/A

Invoked By: R1RSC (R2XSTD entry point);
R3COMM, R3STOP, R3WAIT (R1XSTD entry point)

Invokes: RSC local tasks

Inputs:

Parameter	Data Set	Source
Running Active Tasks Beginning of Queue Pointer	REQCPM	RSC tasks

Outputs: None

Processing:

R2XSTD performs the transfer of control from the RSC subsystem to the local tasks in the running task queue. The state of the dispatched process is constructed in registers 13, 14 and 15 of the dispatcher and a return with context switch is used to transfer control. Two entries are provided for dispatch service. R2XSTD acts as a global return linkage and R1XSTD performs a non-returning transfer.

5.1.33 R2XTEP

Mnemonic: R2XTEP

Title: Time Event Processor

Priority: N/A

Invoked By: R1RSC

Invokes: R2XSRT

Inputs:

Parameter	Data Set	Source
Time Event Queue Pointers	REQCPM	R2XTES

Outputs:

Parameter	Data Set	Destination
Time Event Queue Pointers	REQCPM	R2XTEP

Processing:

R2XTEP invokes the processing of Service Request Tables associated with time dependent events. It scans the time event queue to detect those events scheduled for the current time. Each such event is processed by a Service Request Table call. The queue storage associated with such events is released upon the termination of service request processing.

5.1.34 R2XTES

Mnemonic: R2XTES

Title: Time Event Scheduler

Priority: N/A

Invoked By: R2XSRT

Invokes: none

Inputs:

Parameter	Data Set	Source
Scheduling Control Block Pointer	N/A	Register 0 of calling program

Outputs:

Parameter	Data Set	Destination
Time Event Block	REUQLS	RSC Subsystem

Processing:

R2XTES schedules and enqueues service requests for time event processing. It interprets the contents of the Scheduling Control Block by: (1) computing event time in units of the local clock according to the nature of the scheduling request (cyclic or non-cyclic), (2) constructing a time event block, and (3) enqueueing the time event block either into the pre-rollover or post-rollover queue as appropriate.

5.1.35 R3CANC

Mnemonic: R3CANC

Title: Task Cancelling Server

Priority: N/A

Invoked By: any sequence controller local task

Invokes: R2XSCS

Inputs:

Parameter	Data Set	Source
Task Activation Record Pointer	N/A	Calling program (subroutine linkage)

Outputs: None

Processing:

R3CANC provides task cancelling services for sequence controller local tasks which correspond to the X3CANC service available to non-local tasks. R3CANC fetches the Task Activation Record and invokes the task cancelling service R2XSCS.

5.1.36 R3COMM

Mnemonic: R3COMM

Title: Task Communication Server

Priority: N/A

Invoked By: any sequence controller local task

Invokes: R2XSRT, R3WAIT, R3STOP

Inputs:

Parameter	Data Set	Source
Task Activation Record Pointer	REVKWS	Register 9 of RSC WSP
Communication Cell	Task Dep.	Calling Task
Message Control Block	RESMCB	ROM constants

Outputs:

Parameter	Data Set	Destination
Receiver Status	REYRST	R1XCCP
Transient Message Semaphore	REYRST	R1XCCP

Processing:

R3COMM provides communication services for sequence controller local tasks. The task activation record identifies the communication cell address. The appropriate message is retreived using the message control block. If the status message is non-zero, it is transferred to the REYRST data set. If it is less than zero, the transient message semaphore is set to indicate a pending transient message. Service Request Table (SRT) processing is invoked using the SRT in the Message Control Block. Finally, if the termination code indicates task termination, R3STOP is invoked, otherwise R3WAIT is invoked.

5.1.37 R3STOP

Mnemonic: R3STOP

Title: Task Stopping Server

Priority: N/A

Invoked By: R3COMM or any sequence controller local task

Invokes: R2XSTD (R1XSTD entry), R2XSCS

Inputs:

Parameter	Data Set	Source
Task Descriptor Block Pointer	REVKWS	RSC shared workspace

Outputs:

Parameter	Data Set	Destination
Task Activation Record Pointer	N/A (RO)	R2XSCS

Processing:

R3STOP provides for the termination of a sequence controller local task upon request of that task. It sets up the Task Description Block for the task cancelling service processor and invokes that processor. Services are concluded by calling the task dispatcher for successor processing.

5.1.38 R3WAIT

Mnemonic: R3WAIT

Title: Task Waiting Server

Priority: N/A

Invoked By: R3COMM or any sequence controller local task

Invokes: R2XSTD (entry R1XSTD)

Inputs: none

Outputs:

Parameter	Data Set	Destination
Task Descriptor Block	REUQLS	RSC Subsystem

Processing:

R3WAIT provides processor abdicating services for sequence controller local tasks. The state vector (PC, WP and ST) of the calling task is stored in the Task Descriptor Block with the PC advanced over the argument count and the the Task Dispatcher is invoked for successor task processing.

5.1.39 T1BITT

Mnemonic: T1BITT

Title: Built In Test

Priority: Open Background

Invoked By: EXECUTIVE

Invokes: X3ACT, X3CANC, X3POLL

Inputs:

Parameter	Data Set	Source
Receiver State Code	RCNTRL	R2XSMP
Starting Step	MBCCSA	M2PRMT
CDU Data	N/A	X3POLL
10 MHz Oscillator Status	N/A	EIOM
Local Oscillaors Status	N/A	BITE Module
Commanded Mode	RCNTRL	R1XCCP
Receiver Status(RCBITS)	RCNTRL	R1XCCP
Warm Start Latch	N/A	EIOM
DHO Data	N/A	EIOM
Standby Timer	N/A	EIOM
FTF Count	XCOUNT	Executive

Outputs:

Parameter	Data Set	Destination
Step Code	MBCCSA	M2CDUF
Keyboard Test Code	MBCCSA	M2CDMI, M2CDUF
DHO Data	N/A	EIOM
Warm Start Latch	N/A	EIOM

Processing:

T1BITT performs the Built In Test (bite) function for the MVUE. BITE is selected by the operator through the CDU. The operator is required to supply an initial step number, from 1 to 5, inclusive. The executive is then commanded to perform a software reset. In the power up sequence that ensues, the normal lowest level background task (X1TST) is cancelled and T1BITT is activated. T1BITT then runs during any time not used by the other tasks.

The selected test and all others following it are then performed. A failure causes T1BITT to report the failed step code, which is used by Master Control to display a two character failure message on the CDU. The following steps may be entered by the operator:

(1)10 MHz reference oscillator test. The status of the 10 MHz oscillator is read through the EIOM. A failure of this test causes the message OS to be displayed.

(2)EIOM test. This test consists of a warm start latch test, a standby timer test and a DHO test. Failure of any of the three causes the message EI to be displayed to the operator.

(3)CDU keyboard test. A flashing 0 is displayed to the operator. The operator then enters the keystroke sequence GRD, LAT, TIM, 6, 8, -. Any keystroke other than these causes the message KB to be displayed.

(4)Local oscillators test. The status of 8 different oscillator monitoring circuits is read through the BITE module. A failure causes the message LO to be displayed.

(5)Receiver failure analysis test. The results of the BITE sequence (mode 1) are analyzed and a code generated which indicates to the operator which test in the BITE sequence failed. If none failed, the message OK is displayed.

5.2 MASTER CONTROL SUBSYSTEM MODULE DESCRIPTIONS

The following subparagraphs provide module level descriptions for each of the modules which make up the Master Control Subsystem.

5.2.1 M1CNSV

Mnemonic: M1CNSV

Title: C/No Monitor Task

Priority: 2 second

Invoked By: Executive

Invokes: None

Inputs:

Parameter	Data Set	Source
Filter sequence constants	MGCNOK	M9DATA
C/No values and transmitter ID	RMASNR	R1RNG

Outputs:

Parameter	Data Set	Destination
Warning message and flag	MBCCST	M1S100

Processing:

M1CNSV monitors the signal to noise ratio C/No. C/No measurements are received and filtered by M1NSVC. If a filtered value falls below a specified threshold the warning message of a flashing "G" is displayed on the CDU.

M1CNSV has three functional sequences. During the initialization sequence M1CNSV computes an average C/No measurement for each SV or GT once it enters P-code reacquision. This value is used as the initial input to the filter sequence. During the filter sequence the filtered output from the C/No measurement is computed as a convex combination

of the previous filtered output and the C/No value that has just been passed from R1RNG. In the bad signal sequence it is determined if the filtered output is below the threshold and the warning message is displayed if it is.

Once an SV or GT enters P-code reacquisition the initialization sequence is entered. The initialization counter is then checked to determine if ten measurements have been received. The average C/No measurment is then computed from these ten measurements.

Once an SV or GT has been initialized the filtered output is computed as a linear convex combination of the initial value or the previous filtered output and the value for C/No that has just been received from R1RNG according to the following equation:

$$f(n) = (1-k)(C/No) + k(f(n-1))$$

where $f(n)$ = the nth filter output, $k = 0.875$

This value is converted to dB Hertz for comparison with the appropriate threshold for either a SV or a GT. If the value is within tolerance the bad signal flag is cleared and the current execution of M1CNSV is complete. If the value is below the threshold the bad signal sequence is executed.

In the bad signal sequence it is first determined if the bad signal for this particular SV or GT has previously been reported by checking the bad signal flag. If so it is determined if 3 minutes has passed since it was last reported and if so it is reported again. If not then the bad signal flag is set, the 3 minute redisplay count is set, and the warning message is set to be displayed. Note that if the signal to noise ratio remains low for a particular transmitter, the

warning message will be displayed every 3 minutes for that transmitter, but if the filtered output indicates a good ratio and then a bad ratio before the 3 minutes have passed the warning message will be redisplayed immediately. However, two warning messages within 3 minutes most likely would be the result of two transmitters failing the filter test within that same 3 minute period.

5.2.2 M1NS20

Mnemonic: M1NS20

Title: Acquisition Control Task

Priority: 20 millisecond

Invoked By: Executive

Invokes: M2CDMI, X3ACT, X3CANC, X3TIME, X3TIMM

Inputs:

Parameter	Data Set	Source
Auto almanac acquisition flag	MABCCS	M2PRMT
CDU input/output flag	MABCCS	M1S100 M2CDMI
Warning message semaphore	MBCCST	M1S100
AAA collection from new SV flag	MCDBPA	M2DBPR
Data block collection status	MCTDBP	M2DBPR
SV aiding complete flag	MNAICN	N2MAID
Precision time command flag	MNBEGN	N1MINT
Outer loop SV number	MNPSVN	N1MINT N1MMIT N1MNFL
SV acquisition control flag	MQMSQC	M1ST5M
SV array used in navigation	NGGSVP	N1MSVT N2MSVS
SV elevation array	NMAPPL	N1MSVT N2MSVS
Number of visible SV's	NMAPPL	N1MSVT N2MSVS
Gain computation flag	NMINIT	N1MINT N1MNFL
System true time	NMSIFC	M2CDUF N1MMIT
Subframes complete flag	RMCTRL	R1DSC
RCSS/MCSS status messages	RMMSGS	R1XCCP
SV almanac ID	RMSVDT	R2PCK
Receiver FTF resync data	RMZSYN	R1RSC

Outputs:

Parameter	Data Set	Destination
Warning messages and flag	MBCCST	M1S100
SV status data	MCSVST	M1NSVC M2RMOD
Data block collection status	MCTDBP	M2DBPR
SV aiding control flags	MNAICN	N2MAID
Altitude hold control flags	MNAICN	N1MINT N1MMIT N1MNFL N2MFOT
Precision time command flag	MNBEGN	N1MINT
Outer loop SV number	MNPSVN	N1MINT N2MSCI
Number of SV's being tracked	MNPSVN	M2MAID
CDU standby flag	MQMSQC	M1S100
SV acquisition control flag	MQMSQC	M1S100
WARMSTART precision time flag	MQMSQC	M1ST5M
Receiver command mode data	MRCOMD	R1RSC
RESTART FTF count	MSBCCS	M1ST5M
SV sequence array (high to low)	MVSVSQ	M1NSVC M2EPHM M2RMDC M2RMOD

FTF update command data	MXFTFU	X1IT20
RESTART flag	MXSRS	M1ST5M X2IPWR
Elevation change semaphore	NMAPPL	M1NSVC
Gain computation flag	NMINIT	N1MINT
System true time	NMSIFC	M2CDUF N1MINT N1MSVT N2MAID

Processing:

M1NS20 executes the SV acquisition control logic when the SV acquisition control flag is set. When acquisition is completed the flag is reset by M1NS20. When acquisition is not in progress M1NS20 activates M2CDMI every 20 milliseconds for CDU input/output and MIS service processing.

M1ST5M sets the SV acquisition control flag after system initialization is completed. M1NS20 then fetches the SV elevation array that was either determined by operator input or the SV selection task N1MSVT. If power up is from COLDSTART M1NS20 must first perform first SV acquisition control and precision time calculation control. If power up is from WARMSTART and precision time was completed then M1NS20 begins with subsequent SV acquisition control.

For first SV acquisition M1NS20 commands receiver mode 2 and monitors the receiver SV status. The receiver sequencer replies with command acknowledgement and completion codes through the receiver-sequencer-command data set, RMMSGS. This process is allowed 75 seconds and is repeated up to three tries if the SV is not found. If the SV is not found M1NS20 will choose the next highest SV for first SV acquisition until the first 4 SV's in the elevation array have been tried. If none of these are acquired the receiver failure message, a flashing "R" will be displayed on the CDU and a RESTART commanded. After the first SV is acquired and data recovery is completed M1NS20 orders precision time calculation by the navigation subsystem and FTF resynchronization by the executive. It also

computes the clock bias and activates the navigation modules to generate aiding data for subsequent SV acquisitions.

For subsequent SV acquisitions, M1NS20 proceeds to the next SV in the elevation array to be acquired and commands receiver mode 3 for the acquisition attempt. A 30 second time limit is allowed for each attempt and a maximum of three attempts is made for each SV. This procedure is followed until all SV's in the elevation array have been attempted. If less than 4 SV's are acquired the system warning message for too few SV's, a flashing "S", is ordered displayed. If less than 3 SV's are acquired a RESTART is commanded. If exactly 3 SV's are acquired M1NS20 sets up Altitude Hold to be performed on the 4th slot.

Acquisition having been completed M1NS20 next commands C/A reacquisition for the first SV and then activates the SV reacquisition and sequencing control task, M1NSVC. M1NS20 also cancels the navigation initializaion task, N1MINT, and activates the navigation task, N1MNVT.

5.2.3 M1NSDT

Mnemonic: M1NSDT

Title: Two Second Control Task

Priority: 2 second

Invoked By: Executive

Invokes: M3LSBZ, M3STCR, X3TIME, X3TIMM

Inputs:

Parameter	Data Set	Source
Receiver status	MCSVST	M1NSVC M1NS20 M2RMDC
FTF at time of fix	MCXFOU	M1XFRM
User position	MCXFOU	M1NSWC M1XFRM M2EFLD M2MSLH
Altitude	MNBEGN	M1NST2 M1S100
SV ephemeris data	MNEPHM	M2BDS2 M2DBS3
Inverted range GT data	MNGTDS	M2DBS1
SV pointer data	MNPSVN	M1NSVC M1NS20
SV replacement flags	MNSVSC	M1NSVC M2RMOD N1MSVT
Polynomial coefficients	MNTCDS	M2DBS1
Reference GPS time	MNTCDS	M2DBS1
MIS data control	MOIUSC	M2CDMI
First fix processed flag	MPFIXD	M1S100
Initialization flags	MQMSQC	M1ST5M M1S100 M2CDUF
MIS processing constants	MQSVSQ	M9DATA
SVID acquisition pointer	MRCOMD	M1NSVC M1NS20
MIS output requested flag	MSBCCS	M2CDUF
SV sequence according to height	MVSVSQ	M1NSVC M1NS20
Processor error flag	MXPERM	X1RPRT
Atmospheric correction	NAGINR	N1MINT N2MINC
NAV subsystem time parameters	NAGINR	N1MINT N1MVST N1MSVT N2MSCI
Computed range	NAGINR	N2MRNG
Measured range	NAGINR	N1MNVT N2MSCI
Kalman covariance matrix	NBGOUT	N1MINT N2MCPR N2MCUP
Kalman filter range gains	NCRGNS	N1MINT N1MNFL
Satellite orbit fit coefficients	NGGSVP	N2MSVP
NAV usable SV array	NGGSVP	N1MSVT N2MSVS
SV elevation array (high to low)	NMAPPL	N1MSVT
Gain complete flag for each SV	NMINIT	N1MINT
Excessive oscillator bias flag	NMSIFC	N2MAID
Range bias, Range-rate bias	NMSIFC	N1MMIT
Spherical position error	NMSIFC	N1MNFL
User position and velocity	NMSIFC	M2CDUF N1MMIT
User time when signal received	NMSIFC	N1MMIT N2MSCI
NAV aiding data	NRAID	N2MAID
Precision time data	NRTIME	N2MAID
RCSS/MCSS status messages	RMMSGS	R1XCCP
Receiver time data for resync	RMZSYN	R1RMO R1RSC R1TRK

MIS receiver output mode flag	RMZSYN	M2CDUF
Receiver range measurement data	RNMEAS	R1RMO
Receiver ionospheric meas. data	RNIONS	R1RMO

Outputs:

Parameter	Data Set	Destination
Warning message array and flag	MBCCST	M1S100
MIS data and data control	MOIUSC	M2CDMI
Initialization flags	MQMSQC	M1NS20 M1NSVC M1ST5M M1S100
Receiver mode (for calibration)	MRCOMD	R1XCCP

Processing:

M1NSDT is the system error monitor and reporting task as well as the MIS data output task. M1NSDT monitors and controls the reporting of the following system errors: (1) Processor error, flashing "W" displayed, (2) User position error, flashing "P" displayed, (3) low battery condition, flashing "B" displayed, (4) Excessive oscillator bias, flashing "K" displayed, and (5) Receiver failure, flashing "R" displayed. If the MIS output system has been enabled and the Receiver calibration sequence has completed, M1NSDT initializes the output of MIS data and performs the transfer of MIS data to the MIS output buffer from where it will be recovered by M2CDMI and output through the DHO port of the MVUE. M2CDMI controls the use by both M1NSDT and itself of the proper MIS buffer by flip-flopping the buffers at every 2 second time boundary.

A processor error message is reported to the CDU only the first time such an error is logged by X1RPRT.

Monitoring for a user position error condition is began after the first fix has been attained. An error is reported to the CDU if N1MNFL has computed a spherical position error greater than the set threshold for excessive user position error. Once an error is reported M1NSDT delays for three minutes before again testing for the

user position error condition.

M1NSDT calls the function subprogram M3STCR to check for a low battery condition. If three consecutive low readings are received an error is reported to the CDU. If all readings continue to be low the error will be displayed every three minutes. Whenever a good reading is received the reporting process is restarted and three consecutive low readings will again cause the error to be displayed.

N2MAID determines if the Range-Rate Bias has exceeded the threshold value indicating an excessive bias in the MVUE oscillator. If this occurs a flag is set for M1NSDT to display the warning message. It is reported only once.

M1NSDT activates and controls Receiver calibration during system power up. If BITE is active no calibration is required. If calibration has been completed or is not required M1NSDT proceeds on to MIS data control. M1NSDT waits for Receiver Subsystem initialization to complete before beginning calibration. Up to six seconds will be allowed for each calibration attempt and up to three attempts will be made before a receiver failure is reported to M1NSDT. If calibration is not successfully completed and the warning message had not been displayed since the last COLDSTART or RESTART was performed, then the warning message will be displayed and flags set so that even if this condition has occured on a WARMSTART the system will not proceed on to acquisition, but wait for the depression of the FIX button to activate acquisition, allowing the user to request BITE if desired.

M1NSDT next executes MIS data control. If the MIS flag has been set by M2CDUF then MIS data output is initialized by M1NSDT on its

next execution. A call to M3LSBZ is used to enable data transmission through the DHO port. MIS output is enabled in M2CDMI by setting the MISOUT function flag and the MISOUT read flag. Pointers to the proper 2-second and 24-second data and the end-of-buffer flag are initialized. The current 2-second period is computed by a call of the function subprogram X3TIMM. If SV acquisition has not been enabled this calculation is repeated until it has been.

On the initial and subsequent executions of the MIS output function by M1NSDT the 2-second period pointer is incremented and cycled to the zero-th period after the eleventh period. Until NAV filter gains are completed for a SV the period is reset to the zero-th period. When a new 24-second period is entered the 24-second data pointer are resequenced, the FTF retreived by X3TIME, and the Error Covariance data is moved to a separate buffer for its output.

Output of the proper 2-second and 24-second data by M1NSDT to the current write buffer is accomplished while M2CDMI is reading the other buffer for output through the DHO port. The special receiver 2-second data mode flag is checked and this data is output instead of the normal 2-second data if the special mode is active. This data is zeroed if a status check reveals that it is not valid. The 2-second period pointer then is checked to branch to the proper sub-frame of 24-second period data. M1NSDT completes its current execution with the output of the current subframe of the 24-second data.

5.2.4 M1NST2

Mnemonic: M1NST2

Title: Fix Control

Priority: 1 second

Invoked By: Executive

Invokes: none

Inputs:

Parameter	Data Set	Source
Geodetic altitude	MCXFOU	M1XFRM
Transform data set control flag	MCXFOU	M1NSWC M1S100
Coordinate selector for Fix	MPFIXD	M1S100 M2CDUF
Auto Mode flag	MPFIXD	M1S100
First Fix flag	MPFIXD	M1ST5M M1S100
Fix control flag	MQMSQC	M1S100 M2CDUF
User coordinates from NAV	NMSIFC	M2CDUF N1MMIT
Coordinates available flag	NMSIFC	N1MMIT
User time when signal received	NMSIFC	N1MMIT N2MSCI

Outputs:

Parameter	Data Set	Destination
Coordinates for output	MCXFOU	M2CDUF M2EFLD
Transform data set control flag	MCXFOU	M1NSWC M1S100 M1XFRM
Coordinate conversion code	MCXFOU	M1XFRM M2EFLD M2GPMG M2MSLH
Geodetic altitude	MNBALT	M1NSDT N1MINT N2MINC
Auto Mode flag	MPFIXD	M1S100
Fix control flag	MQMSQC	M2CDUF

Processing:

M1NST2 executes the Manual/Auto Mode display control logic. It interfaces with M1S100 to perform Fix control and Auto Mode function control.

M1NST2 begins with a loop that waits for the First Fix to be performed. A Fix will not be requested until the First Fix. After it is performed the Auto Mode control logic is added to the loop. When in the Auto Mode the display timer is decremented until it is time for a display, then the Auto Mode flag is set to inform M1S100 to perform

an Auto Mode display and the timer is reset.

In the "FIX CONTROL" section M1NST2 initializes the Auto Mode timer when the First Fix is performed. The timer is decremented after every call to X3WAIT. After the Coordinate Transformation Data Set and the NAV Coordinate Data Set are ready the Current NAV Coordinates are transformed to be displayed in the appropriate coordinate system. Altitude is recorded for display since it is processed through Fix Control. The Fix Control display flag is reset. When the transformation is complete M2CDUF handles the sebseqent processing of the display itself.

5.2.5 M1NSVC

Mnemonic: M1NSVC

Title: Reacquisition and Sequence Control Task

Priority: 2 second

Invoked By: Executive

Invokes: M2RMDC, M2RMOD, X3ACT, X3STOP, X3TIMM

Inputs:

Parameter	Data Set	Source
CDU input/output flag	MABCCS	M1S100 M2CDMI
SV status data	MCSVST	M1NS20 M2RMDC
Altitude hold mode flag	MNAICN	M1NS20 M2RMDC
SV sequencing pointers	MNPSVN	N1MINT N1MMIT N1MNVT N1MNFL
Number of SV's being tracked	MNPSVN	M1NS20
SV selection/replacement data	MNSVSC	M2RMOD N1MSVT
Ephemeris authorization flag	MQMSQC	M1ST5M M2PRMT
C/A or P code reacquisition flag	MQMSQC	M1NS20
Ionospheric correction period	MQSVSQ	M2RMOD
Receiver command mode data	MRCOMD	M1NS20 R1XCCP
SV sequence array (high to low)	MVSVSQ	M1NS20 M2RMOD
Ionospheric correction timer	MVSVSQ	M2EPHM M2RMOD
Last 2 previous receiver modes	MVSVSQ	M2RMOD
Ephemeris control flags	MVSVSQ	M2EPHM M2RMDC
SV replacement array	MVSVSQ	M2EPHM M2RMDC M2RMOD
Number of SV's in sequence	MVSVSQ	M2RMOD
Altitude hold timing control	MVSVSQ	M2RMDC
Array of pointers to Nav aiding	NMAPPL	N1MSVT
Number of visible SV's	NMAPPL	N1MSVT
Filter convergence flag	NMINIT	N2MAID
Gain computation flags	NMINIT	M1NS20 N1MINT N1MNFL
Fit coefficient computation flag	NMINIT	M2EPHM
SV almanac ID	NRAID	N2MAID
C/No measurement	RMASIG	R1RNG
RCSS/MCSS status messages	RMMSGS	R1XCCP
Rcvr measurement validity flag	RMMSGS	R1RMO

Outputs:

Parameter	Data Set	Destination
Warning messages and flag	MBCCST	M1S100
First fix request flag	MBCCST	M1S100
SV status data	MCSVST	M2RMOD
Data block collection status	MCTDBP	M2EPHM
SV almanac ID	MFCNOV	M1CNSV
SV aiding pointer	MNAICN	N2MAID

Altitude hold pointers	MNAICN	N1MMIT N1MNFL N2MFOT N2MCUP
SV sequencing pointers	MNPSVN	N1MMIT N1MNVT N1MNFL N2MSCI
Number of SV's being tracked	MNPSVN	N2MAID
SV selection/replacement data	MNSVSC	N1MSVT
Receiver command mode data	MRCOMD	R1XCCP
RESTART FTF count	MSBCCS	M1ST5M
SV sequence array (high to low)	MVSVSQ	M2EPHM M2RMDC M2RMOD
Ionospheric correction control	MVSVSQ	M2EPHM M2RMDC M2RMOD
Ephemeris clock	MVSVSQ	M2RMDC
SV reacquisition timer array	MVSVSQ	M2RMOD
Last 2 previous receiver modes	MVSVSQ	M2RMDC M2RMOD
Ephemeris control flags	MVSVSQ	M2EPMH M2RMDC
SV search pointers	MVSVSQ	M2EPHM M2RMDC M2RMOD
SV replacement array	MVSVSQ	M2EPHM M2RMDC M2RMOD
C/No measurement array	MVSVSQ	M2RMOD
Setting SV control flags	MVSVSQ	M2RMOD
FTF update commands	MXFTFU	X1IT20
RESTART flag	MXSRS	M1ST5M X2IPWR
Gain computation flag	MNINIT	N1MNFL

Processing:

M1NSVC schedules SV reacquisition and sequencing in steady state. Its main functions are: (1) Schedule first fix display, (2) Initiate C/A reacquisition for each SV in the 2 second innner loop control cycle by issuing appropriate receiver and navigation control commands to the receiver sequencer and the navigation filter respectively, (3) Initiate P reacquisition control after the C/A reacquisition process is complete, (4) Carry out SV searching strategy if the number of SV's being tracked is less than 6, (5) Implement and drop altitude hold as required when the number of SV's in sequencing changes from 4 to 3 or from 3 to 4 respectively, (6) Perform steady state SV sequence control including the scheduling of the atmospheric correction SV for an L1/L2 measurement every outer loop, (7) Schedule and control ephemeris update data collection, and (8) Command the display of the appropriate system warning message on the CDU if a system failure condition occurs.

M1NSVC is initially activated by executive call from M1NS20 after the completion of the acquisition mode. It communicates with the

receiver sequencer through the RMMSGS data set. C/A reacqusition is activated first. The SV to be reacquired is determined and receiver mode 4 is commanded. This process is repeated for each SV that was acquired in the acquisition mode by M1NS20. After C/A code is recovered for any SV the reacquisition is switched to P code reacquisition.

In P reacquisition M1NSVC commands the same parameters as in C/A reacquisition except P code is being used in place of C/A code. After the P reacquisition has been commanded, M1NSVC and its subtasks, M2EPHM, M2RMDC, and M2RMOD, control the receiver measurement sequence in the normal navigation, the atmospheric correction, and the data recovery (ephemeris update) cycles.

In the normal navigation cycle, M2RMOD sets the receiver mode to mode 5, the measurement type to L1, and the receiver sequencer to P reacquisition. It also specifies to the navigation system the SV for range and range-rate aiding, and the SV for which navigational measurements apply.

In the atmospheric correction cycle, control parameters are the same as those of the normal cycle except the receiver sequencer control mode is mode 6 and an L1/L2 measurement cycle will be performed on the outer loop SV. This process takes 4 seconds since there is both an L1 and an L2 measurement to be made instead of just an L1 measurement.

In the data recovery cycle, the receiver sequencer mode is mode 7. This cycle requires 8 seconds, 2 seconds for SV reacquisition and 6 seconds for the 3 subframes of data recovery.

In the normal, atmospheric, and data recovery cycles the

following control information is updated for sequencing control operations: (1) SV for current measurement cycle, (2) SV for next aiding, (3) SV for next navigation inner loop, and (4) SV for next navigation outer loop. M1NSVC controls the above sequence information via the SV sequence data base and the SV status table.

In addition to the above control information the following process functions are controlled: (1) Interface between the navigation inner and outer loops, (2) Scheduling of atmospheric correction cycles, (3) Data block processing activation and checking for completion of data recovery, (4) Initiation of a full ephemeris update every hour if operator approved and scheduling data recovery for a newly acquired SV, (5) Reacquisition attempts for SV's whose signals have been lost, and (6) New SV acquisition attempts.

Depending on whether missing measurements for an SV are due to failure to achieve carrier lock or actual loss of signal, two types of SV reacquisition modes will be issued to try to reacquire the SV: (1) If the instantaneous C/No ratio is above its threshold the normal sequencing reacquisition mode will continue to be used, that is code peak search will continue to be executed using receiver sequencer mode 5, and (2) If the instantaneous C/No ratio is below its threshold the sequencial SV reacquisition mode, mode 24, will be commanded for a searching period of 4 minutes before this SV is dropped from the sequence and placed into the new SV search queue.

As soon as the number of SV's tracked drops below 4, M1NSVC will start altitude hold activity on the SV which has missed measurements. M1NSVC will schedule the altitude hold mode on the SV inner and outer loop slots two seconds prior to the normal sequence of its outer

loop. If this SV is dropped, M1NSVC will schedule the new SV acquisition mode and the altitude hold mode for the slot immediately following the 11 number of SVs being tracked after the SV is dropped. If the SV is reacquired before it is dropped from the sequence then the number tracked will be incremented by one and the altitude hold mode will be dropped 2 seconds prior to normal sequence of the outer loop for that SV. IF the number of SV's is still less than 4, M1NSVC will reschedule the altitude hold mode on the other SV slot which is in reacquisition mode 24 if another SV is in this mode or on the new SV acquisition slot which is in mode 8 if another mode 24 slot is not available.

M1NSVC and M2RMOD will always schedule new SV acquisition on the next slot above the number being tracked whenever there is an available SV in the new SV searching queue. The mode 8 searching time limit is set to 4 minutes to cover the 1000 p-chip sequencial search about two times. If a new SV is acquired M1NSVC will schedule it into the sequence. The navigation subsystem will compute self-aiding for this SV until ephemeris is recovered and new fit coefficients are computed. M1NSVC will schedule ephemeris data recovery and set flags for Nav for fit coefficient calculation when the ephemeris data recovery is completed by M2EPHM. The outer loop will not be scheduled until Nav resets the flag indicating that the fit coefficient computation is complete. The number of SV's tracked will then be incremented by one. In case the altitude hold mode was scheduled on the new SV acquisition slot and the new SV acquisition process is complete, the altitude hold mode will be dropped. However, if the number of SV's tracked is still less than 4 M1NSVC will reschedule the

altitude hold mode on another mode 24 or mode 8 SV slot. M2RMDC is used to record the SV status under different system operation modes.

5.2.6 M1NSWC

Mnemonic: M1NSWC

Title: Waypoint Control

Priority: 3 minute background

Invoked By: Executive

Invokes: None

Inputs:

Parameter	Data Set	Source
User position	MCXFOU	M1XFRM M2EFLD
Waypoint control data	MWPCOD	M2CDUF M2PRMT
Waypoint position	MWPCOD	M2CDUF
User position and update flag	NMSIFC	N1MMIT

Outputs:

Parameter	Data Set	Destination
Waypoint position	MCXFOU	M1XFRM M2EFLD
User position	MCXFOU	M1XFRM M2EFLD
Range and bearing to waypoint	MWPCOD	M2CDUF

Processing:

The waypoint control module, M1NSWC, controls waypoint display and the display of range and bearing to a waypoint. It enables M1XFRM to perform the necessary coordinate transformations. M1NSWC has two modes. It controls the display of the current selected waypoint in either latitude and longitude or in military grid coordinates. It also computes and controls the display of the range and bearing from the current user position to the current selected waypoint.

The waypoint operation flag, MWPOPF, controls the mode of operation of M1NSWC. To activate waypoint display it is set to -2 by M2CDUF and M1NSWC returns +2 to indicate completion of coordinate transformations to M2CDUF which then controls further processing and the display. To compute waypoint range and bearing the waypoint

operation flag is set to -3 by M2CDUF and M1NSWC returns +3 when the calculations are completed and M2CDUF commands the display.

In the waypoint location display mode M1NSWC monitors the coordinate transformation data set until it is free and then places the selected waypoint's latitude and longitude which are stored in semicircles into the data set along with an altitude of zero and the display code for either latitude and longitude or military grid coordinates. After the transformations are complete M1NSWC is finished and M2CDUF controls the rest of the processing and the display.

In the range and bearing display mode M1NSWC monitors both the flag indicating coordinate transformation activity and the flag indicating that a user position update is in progress. When neither activity is in progress the user position and velocity are transferred into the coordinate transformation data set. The user position update flag is again checked for a new update and if one has occured M1NSWC loops back to pick up the new update. Finally the coordinate transformation code is set to translate the user position into latitude and longitude in semicircles. Coordinate transformation is then monitored until completion at which time range and bearing are computed and coordinate transformations freed for other use. M1NSWC then sets the waypoint operation flag to indicate to M2CDUF that the display can now be created.

5.2.7 M1PDBR

Mnemonic: M1PDBR

Title: Data Block Processing Control Task

Priority: 6 second, foreground

Invoked By: Executive

Invokes: M2DBS1, M2DBS2, M2DBS3

Inputs:

Parameter	Data Set	Source
Processing Flag	MCDBPA	M2DBPR, M1PDBR

Outputs:

Parameter	Data Set	Destination
Processing Flag	MCDBPA	M1PDBR, M2DBS1
Processing Complete	MCTDBP	M1NS20

Processing:

This routine calls the appropriate data block processing subtask depending upon how the processing flag is set. It then resets that flag and sets another to notify the Master State subsystem it has processed the data.

5.2.8 M1S100

Mnemonic: M1S100

Title: 100 Millisecond Control Task

Priority: 100 millisecond

Invoked By: Executive

Invokes: M2CDUF, M2PRMT

Inputs:

Parameter	Data Set	Source
CDU keystroke data	MABCCS	M2CDMI M2CDUF M2NCDF M2PRMT
CDU display control data	MABCCS	M2CDMI M2CDUF M2NCDF M2PRMT
CDU function control flags	MABCCS	M2CDUF
Warning message display control	MBCCST	M1NS20 M1NSVC M2CDUF M2RMDC
First fix requested flag	MBCCST	M1NSVC
Automatic display mode flag	MPFIXD	M1NST2
CDU standby flag	MQMSQC	M1NSDT M2CDUF
RESTART initialization flags	MSBCCS	M2CDUF M2PRMT
Waypoint number	MWPCOD	M2PRMT
AAA successful flag	MXSRS	M2DBS3
Warning array length	MYPRNT	M9DATA
CDU clearing function timer	MYPRNT	M9DATA

Outputs:

Parameter	Data Set	Destination
CDU keystroke data	MABCCS	M2CDMI M2CDUF M2NCDF M2PRMT
CDU display control data	MABCCS	M2CDMI M2CDUF M2NCDF M2PRMT
CDU function control flags	MABCCS	M2CDUF
Warning message display control	MBCCST	M2CDUF
Coordinate trans. drive flag	MCXFOU	M1NST2 M1NSWC M1XFRM
Prompting level entry control	MHDFCN	M2NCDF M2PRMT
Automatic display mode flags	MPFIXD	M1NST2
Waypoint coordinate system flag	MPFIXD	M1NST2
First fix processed flag	MPFIXD	M1NST2 M1NSVC
NAV initialization flag	MQMSQC	M1ST5M
Waypoint number saved	MSBCCS	M2CDUF
Altitude initialized flag	MSBCCS	M2CDUF
Spheriod ID number	MSBCCS	M2CDUF
Waypoint display data	MWPCOD	M1NSWC

Processing:

The CDU control subroutine (M1S100) processes operator interaction with the control display unit (CDU) and controls the

display of information on the CDU.

M1S100 is activated by Executive call from M1ST5M on power up. The "SEGMENT INITIALIZATION" section performs the following functions:

1. Sets flags to clear the power up test pattern and to initialize the prompting levels and keylevel.
2. Defaults the initial output displays of position to be in CONUS and the auto display mode if active to display fix.
3. On cold start sets the master function flag to cause M2CDUF to order display of the flashing "I" initialization required warning message.
4. On restart the current value of time is recovered and flags are set to cause M2CDUF to reinitialize position using the original inputs of latitude and longitude providing position had been initialized. If either position or time had not been initialized a flashing "I" will be displayed.

The "SEGMENT - MAJOR M1S100 CONTROL LOOP" handles the scheduling of CDU input and output. These process functions are flag driven and control is transferred to the appropriate section of M1S100 for control of their function. After a successful AUTOMATIC ALMANAC ACQUISITION and subsequent automatic RESTART the process of pushing the fix button is software emulated by M1S100 to activate acquisition.

The "SEGMENT - SYSTEM WARNING MESSAGES" controls display of warning messages through flags which are used by M2CDMI. The warning message array is looped through until all messages have been completed.

The "SEGMENT - FIRST FIX REQUEST" sets flags to display a fix

through M2CDUF call and signify it has been processed. The CDU is returned to the normal mode of accepting keystrokes.

The "SEGMENT - PROCESS FUNCTIONS" merely call M2CDUF to process one of its many tasks whose control flags are currently set for execution. Control of initialization of position, altitude, time, and waypoint is begun and then instruction initialization for navigation and acquisition is performed. Control of all display is also accomplished.

Operator interaction is initiated when M2CDMI processes keystroke information and passes it to M1S100 through MABCCS. Then M1S100 recognizes operator depression of the CDU control keys: ENT, RAD, SEL, CLR, GRD, LAT, TIM, RNG, ALT, and FIX. Any other key will cause a "?" to appear. During acquisition the CDU is in standby mode and not operator interacive, so if any key is depressed a flashing "X" will be displayed. The "PROCESS KEYSTROKES" section of M1S100 performs the following functions:

1. The ENT key enables either the manual or automatic display mode when depressed. The appropriate mode is selected by reading the CRU latch that indicates the position of the AUTO/MAN selection switch on the CDU.
2. The RAD key when depressed in the control mode frees the CDU for radio interaction. Its depression inhibits the immediately previous keystroke if it has not yet been processed and all other keystrokes until a radio message could be received and displayed.
3. The SEL key when depressed enables calls to M2PRMT to process information in the CDU prompting mode. All

information supplied to the system by the user is input through this mode.

4. The CLR key is intended for prompting use only and a flashing "X" is displayed when M1S100 recognizes the CLR key has been depressed.
5. The GRD key enables M2CDUF to display the last selected waypoint in military grid coordinates. If waypoint 0 (initial user position) was last selected then it will be echoed if it was input in military grid coordinates, but if it was input in latitude and longitude the display will be inaccurate and followed by a flashing "#" sign indicating an illegal operation.
6. The LAT key enables M2CDUF to display the last selected waypoint in latitude and longitude. If waypoint 0 (initial user position) was last selected then it will be echoed if it was input in latitude and longitude, but if it was input in military grid cooridinates the display will be inaccurate and followed by a flashing "#" sign indicating an illegal operation.
7. The TIM key enables M2CDUF to display time.
8. The RNG key enables M2CDUF to display the range and azimuth from the current user position to the last selected waypoint. A "?" will appear if no waypoint was selected.
9. The ALT key enables M2CDUF to display the mean sea level altitude when in sequencing. A flashing "X" is displayed otherwise.
10. The fix key enables M2CDUF to find a user position fix. If

the system has not be initialized a flashing "I" will be displayed. If the system has just been initialized acquisition is activated.

5.2.9 M1ST5M

Mnemonic: M1ST5M

Title: Start Up 5 Millisecond Control Task

Priority: 5 millisecond

Invoked By: Executive

Invokes: M3LSBZ, M3RTIM, X3ACT, X3CANC, X3STOP

Inputs:

Parameter	Data Set	Source
System initialization flags	MQMSQC	M1NSDT M1S100 M2CDUF
WARMSTART flags	MQMSQC	M1NS20 M2CDMI
RESTART data	MSBCCS	M2PRMT
RESTART flag	MXSRS	M2PRMT
Receiver status flag	RMMSGS	R1XCCP
RAM zeroed flag	XMVUE	X1IPOW

Outputs:

Parameter	Data Set	Destination
System warning message array	MBCCST	M1S100
DATA BLOCK processing flags	MCDBPA	M1PDBR M2DBPR M2DBS1 M2DBS3
Coordinate transform data flag	MCXFOU	M1XFRM M1NST2 M1NSWC M1S100
WARMSTART indicator to NAV	MNBEGN	N1MSVT
MIS initialization flag	MOIUSC	M1NSDT
CDU display data	MPFIXD	M1NST2 M1NSVC M1S100
CDU standby flag	MQMSQC	M1S100
Ephemeris collection flags	MQMSQC	M1NSVC M2RMDC
MIS service control flag	MQMSQC	M2CDMI
System initialization flags	MQMSQC	M1NSDT M1NST2 M1S100
Fix control flag	MQMSQC	M1NST2 M2CDUF
P/CA reacquisition flag	MQMSQC	M1NSVC
SV acquisition control flag	MQMSQC	M1NS20
FTF update flags and FTF count	MXFTFU	X1IT20
RESTART time data	NMSIFC	M2CDUF N1MMIT N1MSVT N2MAID
Receiver status flag	RMMSGS	M1NS20 M1NSVC M1NSDT T1BITT

Processing:

The system start up subroutine (M1ST5M) starts the system up from power off (COLD START), power on to memory only (WARM START), a software restart (RESTART), or a request for built-in-test (BITE). System time (FTF count) and RAM memory are

initialized accordingly for the proper mode. System control flags are initialized. System initialization tasks are activated. Finally either BITE is activated or M1ST5M waits for the completion of navigation initializaion before enabling SV acquisition. M1ST5M is then killed with an Executive call.

The FTF is first defaulted to zero for COLD START. Since WARM START preserves RAM memory, the following are reset by zeroing their control flags: DATA BLOCK processing, SV acquisition, MIS data output, CDU operation mode, error message reporting, fix control, coordinate transformation state, and the warm-up timer. Ephemeris collection control is readied for acquisition.

If start up is from RESTART, system time of power up is updated to the current time, the WARMSTART flag (which was used in conjunction with the RESTART flag to have the executive preserve only the RESTART portion of RAM) is set to indicate this is not a WARMSTART, the week number is restored, and the RESTART flag is reset.

Next activation of the Receiver sequence control is performed and after waiting for initialization of the Receiver Subsystem to complete, the Master State Subsystem tasks are activated.

Now if all of RAM was preserved the power up is for WARMSTART or BITE. In either case the FTF is updated using the old FTF and the STANDBY COUNTER. If Precision Time had been calculated NAV is informed, the CDU is placed in the no operator interaction mode, and N1MSVT is activated to prepare for

acquistion. If Precision Time had not been calculated the NAV initialization flag is set to wait for the FIX button to be depressed to begin acquisition. If BITE had been requested, the BITE task, T1BITT, is activated and then M1ST5M is terminated, both by Executive call. If BITE had not been requested then system initialization is enabled and when completed acquistion is enabled and then M1ST5M is terminated by Executive call.

If part of RAM was zeroed then start up is from COLDSTART or RESTART. System initialization is enabled. The system will now wait for the FIX button to be depressed before enabling acquisition. After acquisition is enabled M1ST5M is terminated by Executive call.

5.2.10 M1XFRM

Mnemonic: M1XFRM

Title: Coordinate Transformation Service

Priority: 2 Second

Invoked By: Executive

Invokes: M2EFLD, M2GPMG, M2MGGP, M2MSLH

Inputs:

Parameter	Data Set	Source
Processing control data	MCXFOU	M1NSWC M1NSVC M1NST2 M1S100
Position coordinates	MCXFOU	M1NSWC M1NSVC M1NST2 M2CDUF
Coordinate transform constants	MELIPS	M9DATA

Outputs:

Parameter	Data Set	Destination
Processing control data	MCXFOU	M2EFLD M2GPMG M2MGGP M2MSLH
Position coordinates	MCXFOU	M1NSDT M1NSVC M1S100 M2EFLD M2GPMG M2MGGP M2MSLH M2OSMG

Processing:

M1XFRM controls, depending on the value of the conversion code, the transformation of positional data among the following coordinate systems:

1. Earth Fixed Rectangular
2. Local Datum Latitude/Longitude and Mean Sea Level Altitude
3. UTM/Military Grid and Mean Sea Level Altitude

Coordinate Transformations are necessary for Fix and Waypoint control operations and for Navigation Initialization Service. Computations involving latitude and longitude are performed in semi-circles. Degrees, minutes, and seconds are computed only if needed for display. The data set MCXFOU is protected by a data set lock flag which is set and monitored by the requesting routine until the transformation is

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complete and the data recovered. This flag is checked by all routines requesting coordinate transformation service in order to wait for MCXFOU to be free for a new calculation.

Earth fixed rectangular coordinates are used for navigation computations. The other two systems are for user input and CDU display of positional information. The Earth fixed system is centered the same as the WGS-72 local datum. Transformations involving other local datums and Earth fixed coordinates are accomplished with the WGS-72 local datum as an intermediary step. User position input and output of altitude uses mean sea level. Geodetic altitude based on the WGS-72 local datum is required as an intermediary step in converting between Earth fixed and either local datum system. Initially and whenever the Datum number is changed the Molodensky altitude correction is calculated to correct the mean sea level altitude from the WGS-72 local datum to the local datum in which the coordinates are required. This correction is applied whenever a transformation involves a datum other than WGS-72. Waypoint calculations assume a mean sea level altitude of zero for both the waypoint and the user position.

The Molodensky correction and conversion from degrees, minutes, and seconds to semi-circles are accomplished by M1XFRM directly. There are nine conversion codes to accomplish calculating the particular information needed by the requesting routine. Control is accomplished by checking the magnitude and the parity (odd or even) of the coordinate conversion code. The proper series of calls to the conversion subroutines required for the particular computation is then executed.

5.2.11 M2CDMI

Mnemonic: M2CDMI

Title: CDU Input/Output and MIS Service Routine

Priority: N/A

Invoked By: M1NS20

Invokes: M3CDUO, M3LSBO, M3LSBZ, M3ODHO, M3STIM, X3TIME, X3TIMM, X3POLL, X3STOP

Inputs:

Parameter	Data Set	Source
CDU keystroke data	MABCCS	M1S100 M2CDUF M2NCDF M2PRMT
CDU display control data	MABCCS	M1S100 M2CDUF M2NCDF M2PRMT
Radio processing data	MABCCS	M2PRMT
BITE keyboard test flag	MBCCST	T1BITT
MIS control data	MOIUSC	M1NSDT
MIS buffer size	MPIUXM	M9DATA
CDU input control flag	MQMSQC	M1NS20 M1ST5M M1S100 M2CDUF
MIS control service flag	MQMSQC	M1NSDT
MIS control flag	MSBCCS	M1S100 M2PRMT
CDU keystroke conversion table	MYPRNT	M9DATA
CDU display constants	MYPRNT	M9DATA
Radio processing constants	MYPRNT	M9DATA

Outputs:

Parameter	Data Set	Destination
CDU keystroke data	MABCCS	M1S100 M2CDUF M2NCDF M2PRMT
CDU display control data	MABCCS	M1S100 M2CDUF M2NCDF M2PRMT
Warning message data and flag	MBCCST	M1S100
MIS control data	MOIUSC	M1NSDT
WARMSTART FTF count	MQMSQC	M1ST5M

Processing:

M2CDMI performs the following functions: (1) CDU Input and Output, (2) STANDBY preparation for WARMSTART or BITE, (3) MIS service, and (4) Radio processing.

M2CDMI is enabled when the system is not in a BITE keyboard test. M2CDMI acknowledges a STANDBY request and performs a STANDBY preparation for a COLDSTART if BITE had previously been requested or

performs a STANDBY preparation for a WARMSTART if BITE had not been requested. M2CDMI uses X3POLL to obtain keystrokes for M1S100 or M2NCDF. M2CDMI uses M3CDUO to send commmands prepared in M1S100, M2CDUF, or M2NCDF to the CDU. When a radio keystroke is obtained, M2CDMI performs the control of radio processing. M2CDMI uses M3LSBO and M3LSBZ in radio control and in WARMSTART and BITE preparation processing. M2CDMI uses M3ODHO to output MIS words.

M2CDMI is called by M1NS20 for normal execution every 20 milliseconds. It returns immediately if a BITE keyboard test is in progress. If a STANDBY request has been acknowledged, M2CDMI does a STANDBY preparation for a WARMSTART if BITE had not been requested, but does a STANDBY preparation for a COLDSTART if BITE had been requested. If MIS has been requested, M2CDMI services MIS and then CDU input and output.

M2CDMI is in the write state when performing CDU output. Before M2CDMI is placed in the write state, an array of CDU output commands is filled and the first and last command locations are recorded. M2CDMI starts with the first command location and outputs one word per call until the last command has been displayed. M2CDMI checks appropriate flags to determine if the display should be extinguished after ten seconds or if the display should be flashed on and off in 0.2 second intervals. After all commands have been displayed and all timing and flashing requests have been processed, M2CDMI switches to the read state for CDU input. M2CDMI is in the read state when performing CDU input. M2CDMI uses two flags to determine when to read a keystroke, a keystroke available flag and a data available flag. The keystroke available flag is negative when a keystroke is available

for processing by another routine (M1S100, M2NCDF, M2PRMT). The keystroke available flag is zero when keystrokes are not requested by any other routines. The keystroke available flag is positive when a keystroke is requested by another routine. The data available flag is zero when M2CDMI has no data from X3POLL to process. The data available flag is negative when a keystroke has been read by X3POLL. M2CDMI will initiate CDU input when a keystroke is requested, it will return when a keystroke is not requested or when the last keystroke that had been read and processed by M2CDMI was not processed by the requesting routine. If CDU data is not available M2CDMI will call X3POLL to obtain data. If no data is available from X3POLL then M2CDMI returns. Once data is available from X3POLL, M2CDMI will perform basic CDU input processing.

If a RAD keystroke is obtained M2CDMI will synchronize the radio and transmit the contents of the CDU display. M2CDMI will handle the timing of the syncronization and transmission. M2CDMI will send the CDU a 60 millisecond command to clear the CDU after the first non-radio keystroke following a radio transmission has been received.

If the data received from the CDU is out of range, M2CDMI will display an "*" in display 1 and read another keystroke. If the CDU has received an illegal command and returns the "illegal command received" data word, M2CDMI will display the flashing system warning message "#" in display 1 and read another keystroke.

M2CDMI will adjust the raw data from X3POLL to allow a keystroke look-up table to be used. M2CDMI will set the three state keylevel flag when an upper-left or upper-right keystroke has been read. M2CDMI will then return and read another keystroke on its next

execution.

The STANDBY flag is set when M2CDMI receives a STANDBY command. The keystroke request is rescinded and M2CDMI returns to process a WARMSTART or BITE function request.

M2CDMI sets special modes of the keystroke available flag for CLR or ENT keystrokes.

When the requested keystroke is a function keystroke, M2CDMI will set the keystroke available flag when a function keystroke is received or will display a "?" in display 1 and return for another keystroke if a non-function keystroke is obtained. When the requested keystroke is a non-function keystroke, M2CDMI will display the character and set the keystroke availabe flag when a non-function keystroke is obtained but, will display a "?" in display 1 and return for another keystroke when a function keystroke is received.

M2CDMI uses a conversion matrix to interpret the data received from the CDU keystrokes. The CDU data ranges from 5 to 31 with a unique data word for each key, for the STANDBY switch, and for the "illegal command received" word. A (3X27) matrix results from the normal, upper-left and upper-right options available for most of the CDU keys. An element of the matrix is negative one if the keylevel and data word is illegal. An element of the matrix is zero if the keylevel and data word corresponds to a function. An element is the "ascii code for the desired character modified for CDU display if the keylevel and data word corresponds to a digit, letter, or punctuation key.

5.2.12 M2CDUF

Mnemonic: M2CDUF

Title: Control Display Unit Function Subroutine

Priority: N/A

Invoked By: M1S100

Invokes: M2NCDF, M3LSBO, M3STIM, X3ACT, X3TIME

Inputs:

Parameter	Data Set	Source
CDU display commands and flags	MABCCS	M1S100 M2CDMI M2NCDF M2PRMT
Initialization data and flags	MABCCS	M1S100 M2PRMT
BITE completion code and KB flag	MBCCSF	T1BITT
Coordinate transformation data	MCXFOU	M1NSWC M1NST2 M1S100 M1XFRM
Digits for display	MHDFCN	M2NCDF
Coordinate system flag	MPFIXD	M1S100
First Fix flag	MPFIXD	M1S100
Precision Time flag	MQMSQC	M1NS20
NAV initialization flag	MQMSQC	M1ST5M M1S100 M1NSDT
Fix control flag	MQMSQC	M1NST2 M1S100
SV ID pointer	MRCOMF	M1NS20 M1NSVC
Initialization data	MSBCCS	M2PRMT
Waypoint data	MWPCOD	M1S100 M1NSWC
10 second timer	MYPRNT	M9DATA
BITE message array	MYPRNT	M9DATA
SV visibility data	NMAPPL	N1MSVT
Spherical position error	NMSIFC	N1MNFL
NAV CDU lockout flag	NMSIFC	N1MMIT
SV ID for acquisition display	NRAID	N2MAID

Outputs:

Parameter	Data Set	Destination
CDU display commands and flags	MABCCS	M1S100 M2CDMI M2NCDF M2PRMT
Initialization data and flags	MABCCS	M1S100
BITE completion code and KB flag	MBCCSF	M2CDMI T1BITT
Warning message array and flag	MBCCSF	M1S100
Coordinate transformation data	MCXFOU	M1NSWC M1NST2 M1S100 M1XFRM
System variable display data	MHDFCN	M2NCDF
Input altitude	MNBEGN	N2MINC
NAV WARMSTART/COLDSTART flag	MNBEGN	N1MSVT
Coordinate system flag	MPFIXD	M1NST2
CDU standby flag	MQMSQC	M1S100
BITE request flag	MQMSQC	M1ST5M
NAV initialization flag	MQMSQC	M1ST5M M1S100
Fix control flag	MQMSQC	M1NST2

WARM START FTF	MQMSQC	M1ST5M
RESTART FTF	MSBCCS	M1ST5M
Initialization flags	MSBCCS	M1ST5M M2PRMT
Waypoint data	MWPCOD	M1S100 M1NSWC
FTF resync commands	MXFTFU	X1IT20
Altitude Hold correction data	NMSIFC	N2MAID
Initial position and time	NMSIFC	M1NST2 N1MMIT N1MSVT N2MAID

Processing:

The Control Display Unit Function Subroutine, M2CDUF, performs the following functions for M1S100: (1) Time initialization, (2) Time display, (3) Altitude initialization, (4) Altitude display, (5) Position initialization, (6) Fix display, (7) Waypoint display, (8) Acquisition status display, (9) Range control, (10) Navigation initialization, (11) BITE preparation, and (12) BITE monitor. M2CDUF accesses the required function through a beginning control loop that branches to the function whose execution flag is set.

Time initialization can be performed when CDU access is available and the system is not in sequencing. CDU time inputs are processed by M2CDUF to calculate the number of complete weeks since January 1, 1978, and the number of seconds from midnight Saturday/Sunday until the unit was powered up from COLD START.

A time display can be commanded by depressing the TIM button except when in STANDBY or acquisition. If Precision Time has been calculated then NAV time is current and is converted for display. If not then the current FTF count is used to adjust the calculation. The time display will be only as precise as the input time if Precision Time has not been calculated. M2NCDF is called to convert the calculated numbers into digits for display.

Altitude initialization can be performed anytime CDU access is user available. If this input is entered before sequencing the altitude value will be incorporated into the initial user position. If

no altitude is entered initially then a value of zero (Sea Level) is assumed in calculating the initial user position. The initial user position is also used by NAV for calculating the Range to the Center of the Earth. If sequencing is attained with only 3 SV's Altitude Hold will be implemented by using the range to the center of the Earth. If altitude is input while sequencing the value will be used to update the Range to the Center of the Earth for Altitude Hold usage.

An altitude display can be commanded when in sequencing by depressing the ALT button. M2CDUF enables a fix computation so that altitude may be extracted. M2NCDF is called to convert system variables to digits for display.

The position initialization function serves to command the computation of coordinates of the initial user position and of all waypoints. They are transformed from input coordinates into Earth centered coordinates. Before sequencing if altitude is entered on the CDU after position then position initialization is recommanded to include the new altitude value. Initial user position must be input before acquisition can be commanded. Waypoints can be input anytime CDU access is available. M1XFRM performs coordinate transformation service.

The Fix display function is used to calculate a fix display of either user position or of the position of a waypoint. User position can be displayed while in sequencing by depressing the FIX button. Initial user position or waypoint position can be displayed whenever CDU access is available by depressing the GRD or LAT button. Initial user position can be displayed only in the coordinate system in which

it was input. A Fix calculation by M1NST2 is requested if needed. Calls are made to M2NCDF to convert the system variables to digits for display.

The Waypoint Display Function prepares the Fix Display Control Function for waypoint display. If the current waypoint number is zero (initial user position) then the waypoint zero array is moved into the coordinate transformation data set for output by Fix Display Control. If the waypoint number is not zero, then M2CDUF monitors the Waypoint Control Function, M1NSWC, while it finishes the preparation and then the Fix Display Contol Function is enabled.

The Range Control Display Function monitors M1NSWC as it calculates the range and bearing to a waypoint. Calls are made to M2NCDF to convert system variales to digits for display.

The Acquisition Status Display Function calls M2NCDF to convert system variables to digits for display and commands the display of the current acquisition status.

The NAV Initialization Function orders the display of the flashing "I" - initialization required - warning message on power up. When the FIX button is depressed before acquisition the NAV Initialization Function is invoked again. If time and position have not been initialized another flashing "I" is commanded. If time and position are both initialized then N1MSVT is activated for SV selection and when SV selection is complete the NAV initialization flag is set to indicate that to M1ST5M.

Built-In-Test (BITE) Preparation commands a system WARMSTART for the purpose of executing BITE. Time and memory are saved and the BITE flag is set to enable BITE.

The BITE Monitor Function is to be invoked when the user selects BITE via the CDU. Some Receiver BITE tests are run automatically during system start up and a flashing "R" warning message displayed if there is a failure. All results remain valid for the sebsequent execution, if the user desires, of full BITE testing. The BITE Monitor Function has its execution flag set to execute every 100 milliseconds when it is called by M1S100. An appropriate message is displayed at any time a test fails. If the keyboard test is to be ran a flashing "O" message is sent to inform the operator to input the keystroke sequence comprising the test. If all tests are successfully completed an "OK" is displayed. After the display of any result further testing is halted unless the operator reselects BITE at the appropriate testing level.

5.2.13 M2DBPR

Mnemonic: M2DBPR

Title: Data Block Collection

Priority: N/A

Invoked By: R1DSC

Invokes: None

Inputs:

Parameter	Data Set	Source
Data Update Flag	RMSVDF	R2PCK
Data Collection Disable	MCTDBP	M1NS20
Auto Almanac Acq	MABCCS	M2PRMT
Word Count	RMSVDF	R2PCK
SV/GT ID Number	MCDBPA	M2DBPR
SV Almanac ID	RMSVDF	R2PCK
Data Validity	RMSVDF	R2PCK
Subframe ID	RMSVDF	R2PCK
Processing Flag	MCDBPA	M2DBPR, M1PDBR
SV Data Word	RMSVDF	R2PCK
Validity Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2
Bit Masks	MDBCON	M9DATA
Prev Pass Word Status	MCDBPA	M2DBPR, M2DBS1, M2DBS2
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2MOVE
Prev AOD/TOC	MCDBPA	M2DBPR
Validity Word Init	MCDBPA	M2DBPR
Prev AODE	MCDBPA	M2DBPR
Chain Loop Count	MCDBPA	M2DBPR
First Almanac ID	MCDBPA	M2DBPR
Chain SV Count	MCDBPA	M2DBPR

Outputs:

Parameter	Data Set	Destination
Data Update Flag	RMSVDF	M2DBPR
Validity Words	MCDBPA	M2DBPR
SV/GT ID Number	MCDBPA	M2DBPR
Prev Pass Word Status	MCDBPA	M2DBPR
Validity Word Init	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2MOVE
Prev AODC/TOC	MCDBPA	M2DBPR
Prev AODE	MCDBPA	M2DBPR
Processed Word Index	MCDBPA	M2DBS3
Chain Loop Count	MCDBPA	M2DBPR, M2DBS3

Chain SV Count	MCDBPA	M2DBPR, M2DBS3
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2DBS3, M2MOVE
Data Collection Status	MCTDBP	M1NS20
SV/GT Number	MCDBPA	M2DBS1, M2DBS2
Almanac ID Number	MCDBPA	M2DBS1
Processing Flag	MCDBPA	M1PDBR, M2DBS1
Prev AOD/TOC	MCDBPA	M2DBPR
First Almanac ID	MCDBPA	M2DBPR
New SV Command	MCDBPA	M1NS20

Processing:

This routine contains the logic for collecting the data words passed from the receiver subsystem. It collects 24 bit words of data, one at a time, and assembles them into complete data blocks for processing by M1PDBR and its subtasks. For satellite data it collects words 8, 9, and 10 of subframe 1 and words 3 to 10 of subframes 2 and 3. For ground transmitter data it collects words 3 to 10 of subframe 1 only. For almanac data it collects words 3 to 10 of subframe 5. If all desired words are not successfully collected in one pass through a subframe, then this routine will attempt to combine passes (except for almanac data collection) to produce a complete subframe. The almanac data is collected only for the automatic almanac aquisition mode and if it cannot get a successful pass in three tries, this routine will notify the Master State subsystem to collect data from a different satellite.

5.2.14 M2DBS1

Mnemonic: M2DBS1

Title: Data Block I Processing

Priority: N/A

Invoked By: M1PDBR

Invokes: M2MOVE

Inputs:

Parameter	Data Set	Source
Processing Flag	MCDBPA	M2DBPR, M1PDBR
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2MOVE
Validity Word Init.	MCDBPA	M2DBPR
SV Time Status	MNTCDS	M2DBS1, N2MSCI
Almanac SV ID	MCDBPA	M2DBPR

Outputs:

Parameter	Data Set	Destination
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2DBS3, M2MOVE
SV Time Data	MNTCDS	N2MSCI
Inverted Range Data	MNGTDS	N2MSVE, N1MINT, N2MAID
Prev Pass Word Status	MCDBPA	M2DBPR
Validity Words	MCDBPA	M2DBPR

Processing:

This routine unpacks the 24 bit data words from subframe 1 as sent by the receiver into the appropriate integer variables and converts to floating point for storing as satellite timing data or ground transmitter position and timing data.

5.2.15 M2DBS2

Mnemonic: M2DBS2

Title: Data Block II Processing

Priority: N/A

Invoked By: M1PDBR

Invokes: M2MOVE

Inputs:

Parameter	Data Set	Source
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2MOVE
Ephemeris Data	MNEPHM	M2DBS2
Validity Word Init.	MCDBPA	M2DBPR

Outputs:

Parameter	Data Set	Destination
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2DBS3, M2MOVE
Ephemeris Data	MNEPHM	N2MSVE, N1MINT, N2MAID, N1MSVT
Prev Pass Word Status	MCDBPA	M2DBPR
Validity Words	MCDBPA	M2DBPR

Processing:

This routine unpacks the 24 bit data words from subframes 2 and 3 as sent by the receiver, applies scale factors and converts to floating point for storing as satellite ephemeris data for use by the satellite position task of the navigation subsystem.

5.2.16 M2DBS3

Mnemonic: M2DBS3

Title: Data Block III Processing

Priority: N/A

Invoked By: M1PDBR

Invokes: None

Inputs:

Parameter	Data Set	Source
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2MOVE
RAM Almanac Data	MNRALM	M2DBS3, N1MSVT
Current Week	NMSIFC	M2CDUF
Chain Loop Count	MCDBPA	M2DBPR
Processed Word Index	MCDBPA	M2DBPR, M2DBS3
Chain SV Count	MCDBPA	M2DBPR
Operator Input Time	NMSIFC	N1MMIT, M2CDUF
Expired FTF Count	MSBCCS	M2PRMT

Outputs:

Parameter	Data Set	Destination
RAM Almanac Data	MNRALM	N2MSVE, M2DBS3
Processed Word Index	MCDBPA	M2DBS3
Processing Flag	MCDBPA	M1PDBR, M2DBS1
Almanac Collected Flag	MXSRS	M1S100
Almanac Selection	NVASEL	N1MSVT
Software Reset	MXSRS	M1ST5M, X2IPWR
Expired FTF Count	MSBCCS	M1ST5M, M2DBS3
Update/Restart Flag	MXFTFU	X1IT20
Command Sent/Received	MXFTFU	X1IT20

Processing:

This routine unpacks the 24 bit data words from the receiver into the appropriate integer variables and converts to floating point for storing in the almanac data set (MNRALM).

If all almanac data has been processed, RAM almanac data is checked for old data left over from ROM. If old data exists, this

routine eliminates it and reorders the almanac array, if necessary. The number of good almanacs is then stored and a software reset is commanded.

5.2.17 M2EFLD

Mnemonic: M2EFLD

Title: Geodetic - Geocentric Conversion

Priority: N/A

Invoked By: M1XFRM

Invokes: None

Inputs:

Parameter	Data Set	Source
Coordinate conversion code	MCXFOU	M1NSVC M1NSWC M1NST2 M1S100
Position coordinates	MCXFOU	M1NSVC M1NSWC M1NST2 M1XFRM
Coordinate transform constants	MELIPS	M9DATA

Outputs:

Parameter	Data Set	Destination
Position coordinates	MCXFOU	M1NSDT M1NSWC M1XFRM M2GPMG M2MGGP M2MSLH

Processing:

M2EFLD performs the coordinate conversions between Earth fixed rectangular coordinates centered the same as the WGS-72 local datum and any local datum latitude/longitude with geodetic altitude based on that local datum. The direction of the transform is determined by the sign of the coordinate conversion code. Latitude and longitude are both used in units of semi-circles. Earth fixed coordinates are in p-chips.

Each local datum is associated with a reference ellipsoid. There are 11 such ellipsoids and 46 local datums. The data set MELIPS provides the semi-major axis and the eccentricity of the reference ellipsoid. Different local datums with the same reference ellipsoid have different centers. MELIPS also provides the offsets of the coordinates of these centers from the WGS-72 center.

Local datum to Earth fixed coordinate transformations are accomplished by computing the rectangular coordinates based at the center of the local datum and then shifting these to the WGS-72 center. Earth fixed to local datum coordinate transformations are accomplished by shifting the rectangular coordinates first to the local datum center and then transforming to latitude, longitude, and geodetic altitude.

5.2.18 M2EPHM

Mnemonic: M2EPHM

Title: Ephemeris Update Scheduler

Priority: N/A

Invoked By: M2RMDC

Invokes: None

Inputs:

Parameter	Data Set	Source
Data Block Collection Status	MCTDBP	M2DBPR
SV Search Time Constant	MQSVSQ	In ROM
SV Sequence	MVSVSQ	M1NS20, M1NSVC
Ionospheric Correction Timer	MVSVSQ	M1NSVC
New SV/Full Ephemeris flag	MVSVSQ	M2EPHM
Ephemeris Rcvr Command Issued	MVSVSQ	M2EPHM
SV Sched. for Ephem. Update	MVSVSQ	M1NSVC
New SV Ephemeris Pointer	MVSVSQ	M2RMDC
Number of SV's in Sequence	MVSVSQ	M2RMOD
Ephemeris Update Counter flag	MVSVSQ	M2EPHM

Outputs:

Parameter	Data Set	Destination
Fit Coefficient Computation flag	NMINIT	N1MSVT, N2MSVP, N2MAID
Source ID Number	MCDBPA	M2DBPR
Aiding Command	MNAICN	N2MAID
Receiver Command Mode	MRCOMD	R1RSC
Receiver SV ID Pointer	MRCOMD	R1RSC
Navigation SV Number	MNPSVN	N1MNIT, N1MNVT
Receiver Status for last Acquis.	MCSVST	M2RMOD
Ephemeris Clock	MVSVSQ	M2RMDC
SV Time and Timer flag	MVSVSQ	M2RMOD
Internal Full Ephemeris flag	MVSVSQ	M2RMDC
Ephemeris Update Timer flag	MVSVSQ	M2EPHM
Start FTF of Ephemeris Update	MVSVSQ	M2EPHM
Ephemeris SV ID	MVSVSQ	M2EPHM
Ephemeris Rcvr Command Issued	MVSVSQ	M2EPHM
SV for Ephemeris Update	MVSVSQ	M2EPHM
Mode Seven flag for SV	MVSVSQ	M1NSVC
Ephemeris Data been Collected	MVSVSQ	M1NSVC

Processing:

M2EPHM, the ephemeris update scheduler is a subtask of M1NSVC used for scheduling details either for ephemeris update of a newly

acquired SV or for the regular hourly ephemeris update of the full complement of SV's.

Upon entering a 24 second period the following checks are performed 1) If this is subframe 1 then check for bad data or roll momentum dump. For bad data check if the source is bad. For roll momentum dump, drop the source and acquire a new one. 2) If this is not subframe 1 and the source is a GT then return. 3) If this is subframe 2 or 3 then also check for bad data or roll momentum dump. 4) If not subframe 1, 2 or 3 then return.

A source is given 3 tries or 360 seconds to receive good data before it is declared bad and dropped. If the data was bad on the first or second try then command the receiver to acquire the source and command aiding to be computed.

When subframes 1, 2 and 3 have been received successfully, then the data flags and time initialization flags are cleared. If the ephemeris for all active sources has not been collected then collect ephemeris for the next source. If any of the sources are new ones, then command fit coefficients to be computed.

During the 4, 6 and 22 second periods, the inner loop SV ID is set to the ephemeris ID. The ephemeris receiver command is set to zero during the 6 second period. For the 22, 2 and 0 second periods the receiver aiding and mode is cleared.

5.2.19 M2GPMG

Mnemonic: M2GPMG

Title: Geodetic to Military Grid or Convergence

Priority: N/A

Invoked By: M1XFRM

Invokes: M2OSMG

Inputs:

Parameter	Data Set	Source
Coordinate conversion code	MCXFOU	M1NSVC M1NSWC M1NST2 M1S100
Latitude and longitude	MCXFOU	M1NSVC M1NSWC M1NST2 M1XFRM
Coordinate transform constants	MELIPS	M9DATA

Outputs:

Parameter	Data Set	Destination
UTM/Military grid coordinates	MCXFOU	M1NSDT M1NSVC M1NSWC M1XFRM M2OSMG
Convergence angle	MCXFOU	M1NSWC

Processing:

Given latitude and longitude in semi-circles M2GPMG computes either UTM/Military Grid coordinates or the convergence angle between true and grid north. The coordinate conversion code determines which computation is required.

When coordinates are required M2GPMG first computes the UTM (Universal Transverse Mercator) parameters: zone number, zone letter, easting and northing. Then the UTM/Military Grid parameters are computed: row letter, column letter, easting, and northing. Subroutine M2OSMG is called to compute the row offset parameter of the reference ellipsoid in which the coordinates are based.

When waypoint range and bearing are requested M2GPMG calculates the convergence angle between true and grid north for use by M1NSWC.

5.2.20 M2MGGP

Mnemonic: M2MGGP

Title: Military Grid to Geodetic

Priority: N/A

Invoked By: M1XFRM

Invokes: M2OSMG

Inputs:

Parameter	Data Set	Source
UTM/Military grid coordinates	MCXFOU	M1NSVC M1NSWC M1NST2 M1XFRM
Coordinate transform constants	MELIPS	M9DATA

Outputs:

Parameter	Data Set	Destination
Latitude and longitude	MCXFOU	M1NSDT M1NSVC M1XFRM M2OSMG

Processing:

M2MGGP converts the UTM/Military Grid parameters zone number, zone letter, row letter, column letter, easting, and northing to latitude and longitude expressed in semi-circles. The Statement Function NUMBR is defined and used to convert an ASCII letter of the alphabet, left adjusted in a word, but excluding the letters I and O, to its position number in the alphabet from 1 to 24. Subroutine M2OSMG is used to calculate the row offset identifier of the reference ellipsoid in which the coordinates are based.

M2MGGP first computes the UTM (Universal Transverse Mercator) parameters of easting and northing using the Military Grid input parameters. Next using the parameters of the local datum from the MELIPS data set the cartesian coordinates of the point relative to the coordinate system determined by the equator and the central meridian of the UTM zone are computed and then this is transformed to latitude

and longitude in semi-circles.

5.2.21 M2MOVE

Mnemonic: M2MOVE

Title: Data Block Processing Utility

Priority: N/A

Invoked By: M2DBS1, M2DBS2

Invokes: None

Inputs:

Parameter	Data Set	Source
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2MOVE
Validity Word Init.	MCDBPA	M2DBPR

Outputs:

Parameter	Data Set	Destination
Data Words	MCDBPA	M2DBPR, M2DBS1, M2DBS2, M2DBS3, M2MOVE

Processing:

This routine shifts the bytes of the data words for ease of processing. The data from the satellites are store as 24 bit words or 32 bit numbers, divided between two words. This routine combines the third byte of one double word (ie. Two 16 bit words in the TI processor) with the first three bytes of the following double to produce one 32 bit number.

5.2.22 M2MSLH

Mnemonic: M2MSLH

Title: Mean Sea Level Altitude Computation

Priority: N/A

Invoked By: M1XFRM

Invokes: None

Inputs:

Parameter	Data Set	Source
Coordinate conversion code	MCXFOU	M1NSVC M1NSWC M1NST2 M1S100
Latitude and longitude	MCXFOU	M1XFRM
Molodensky altitude correction	MCXFOU	M1XFRM
Coordinate transform constants	MELIPS	M9DATA

Outputs:

Parameter	Data Set	Destination
Altitude	MCXFOU	M1XFRM M2EFLD

Processing:

M2MSLH either computes mean sea level altitude from geodetic altitude or computes geodetic altitude from mean sea level altitude. The data set MELIPS contains an interpolation table which gives the difference between mean sea level altitude and geodetic altitude in the WGS-72 datum for each 10 degree increment of latitude and longitude. M2MSLH contains an internal statement function WWW to compute interpolation weights. The Molodensky altitude correction is applied to correct for a different local datum than WGS-72. It will be zero if the calculation is in WGS-72.

First the latitude and longitude of the point are converted into 10 degree units and truncated to compute the interpolation table indices. The interpolation is then accomplished using the weighting function and the altitude correction is computed. Next the coordinate

conversion code is checked to see which direction the correction is to be applied. The proper altitude value is then calculated by appling the interpolation altitude correction and the Molodensky altitude correction. It is also returned in appropriate units.

5.2.23 M2NCDF

Mnemonic: M2NCDF

Title: CDU Formatting Service

Priority: N/A

Invoked By: M2CDUF, M2PRMT

Invokes: None

Inputs:

Parameter	Data Set	Source
CDU keystroke data	MABCCS	M1S100 M2CDMI M2CDUF M2PRMT
Prompting level entry control	MHDFCN	M1S100 M2PRMT
System variable display data	MHDFCN	M2CDUF M2PRMT
Underscore address pointers	MHDFCN	M2PRMT
Prompting and display constants	MYPRNT	M9DATA

Outputs:

Parameter	Data Set	Destination
CDU keystroke data	MABCCS	M1S100 M2CDMI M2CDUF M2PRMT
CDU display control data	MABCCS	M1S100 M2CDMI M2CDUF M2PRMT
System variable display data	MHDFCN	M2CDUF M2PRMT

Processing:

M2NCDF has five service functions to perform. For M2CDUF it creates a system variable from an array of digits. For M2PRMT it creates an array of digits from a system variable, it controls upper prompting displays, it controls the display of prompting underscores, and it controls data entry.

M2NCDF uses a conversion matrix to create a hexadecimal or decimal digit from the ASCII representation of the keystoke obtained from M2CDMI. The ASCII data is obtained by using the keylevel and keystroke data in the (3X27) conversion matrix.

In the system variable to array of digits conversion mode, M2CDUF supplies the mode of operation and data, M2NCDF performs the

conversion and returns. To calculate a system variable from an array of digits and the base of the number system in which those digits are to be expressed, M2NCDF adds the first digit, the second digit times the base, the third digit times the base squared, the fourth digit times the base cubed, and the fifth digit times the base raised to the fourth power.

In the array of digits to system variable conversion mode, M2PRMT supplies the mode of operation and data, M2NCDF performs the conversion and returns. To convert from a system variable to an array of digits, M2NCDF is supplied with a system variable and the base of the number system. The absolute value of the system variable is stored in a temporary variable for internal manipulations. The nth digit is determined by performing modulo arithemetic to the base raised to the nth power. Five digits are found.

In the control of upper prompting displays, M2PRMT provides M2NCDF with a mode, a major prompting level, and a minor prompting level. M2NCDF creates the display commands for upper prompting displays and monitors M2CDMI's display of the commands. Three upper prompting display characters are associated with each major and minor prompting level. To control upper prompting displays M2NCDF calculates the location in the array of upper prompting displays, places the CDU clear command and the three characters to be displayed in the output buffer, and commands the output to be performed. The location in the array is found by determining the sum of the major and minor levels.

For prompting underscores, M2PRMT provides the correct mode, a starting display address, and an ending display address. M2NCDF

creates the underscore commands and monitors M2CDMI's display of the commands. To control the display of underscores M2NCDF adds an underscore character to the display address for each address between the beginning and ending addresses.

For data entry M2PRMT provides M2NCDF with the mode of operation, the type of data, the display address, and the length of the data. M2NCDF requests the keystrokes from M2CDMI and stores the data in an intermediate form. When the proper number of keystrokes of the correct type have been received from M2CDMI control is returned to M2PRMT. For the control of data entry M2NCDF has two modes. In the first mode memory read/write is in progress and a keystroke has been requested by M2PRMT so M2NCDF does not need to prepare for data entry. In the other mode, the non-memory read/write mode, M2NCDF clears the data buffer for hexadecimal, decimal, and zone letter data types and then requests a keystroke to be input and waits for a character to be obtained. Once a character has been obtained, the two modes mesh together to process the character. M2NCDF will return if a CLR or a RAD keystroke is received. CLR requires the underscores to be refreshed and RAD requires prompting to be terminated. If ENT is obtained M2CDMI will return if a function or free text characters have been obtained. Free text prompting may be terminated at any length with ENT and all other data types will be changed to a functional request for ENT when a complete prompting frame has been obtained. If ENT is obtained for decimal, hexadecimal, or zone letter data, M2CDMI will return when the length is correct or will clear the input with underscores if the length is too short. The last option is that data has been obtained. The data is checked for range bounds for decimal,

hexadecimal, and zone letter types. The data is stored in the buffer if the data is in range or a question mark replaces the underscore if the data is out of range. For functional input only one keystroke is needed so M2NCDF will return. After valid data has been stored in the buffer the display address and buffer pointers are updated. If the length of the data is correct M2NCDF will request a keystroke of CLR or ENT to complete the prompting frame input. If the forced prompting input flag is set M2NCDF will not require that CLR or ENT be supplied and will return when the data of the correct length is obtained. M2NCDF will loop back for the next keystroke request if the forced prompting input flag is not set.

5.2.24 M2OSMG

Mnemonic: M2OSMG

Title: Offset to Military Grid Row

Priority: N/A

Invoked By: M2GPMG, M2MGGP

Invokes: None

Inputs:

Parameter	Data Set	Source
UTM designators	MCXFOU	M1S100 M2EFLD M2GPMG M2MGGP

Outputs:

Subroutine Argument	Destination
NNN, the military grid row offset	M2GPMG M2MGGP

Processing:

M2OSMG uses the spheroid number and the UTM zone number and zone letter to compute the military grid row offset, NNN, which is an argument of the subtask.

The argument takes on only 4 values: 0, 5, 10, and 15. The following table lists the conditions under which NNN = 0 if the zone number is odd and NNN = 5 if the zone number is even.

Spheroid Number	Zone Number (n)	Zone Letter
2	n < 47 or n > 51	all
3	50 <= n <= 52	all
4	n <= 51	q, r, s, t, u, v, w, x, y, z
5	n >= 47	all
7	all	all

If the spheroid number is 6 then NNN = 10 if the zone number is even and NNN = 15 if the zone number is odd.

Under all other conditions than those specified above NNN = 10 if the zone number is odd and NNN = 15 if the zone number is even.

5.2.25 M2PRMT

Mnemonic: M2PRMT

Title: Prompting Control

Priority: N/A

Invoked By: M1S100

Invokes: M2NCDF, M3LSBO, X3TIME

Inputs:

Parameter	Data Set	Source
CDU keystroke data	MABCCS	M1S100 M2NCDF
CDU display control data	MABCCS	M1S100 M2CDMI M2NCDF
Prompting level entry control	MHDFCN	M1S100
Prompting level display codes	MHDFCN	M2NCDF
Precision time flag	MNBEGN	M1NS20
NAV initialization flag	MQMSQC	M1S100 M2CDUF
Memory read/write data	MXMRWD	M1S100 X1RPRT
RAM constants	MYPRNT	M9DATA

Outputs:

Parameter	Data Set	Destination
Auto almanac acquisition flag	MABCCS	M1NS20 M2DBPR
CDU keystroke data	MABCCS	M1S100 M2CDMI M2CDUF M2NCDF
CDU display control data	MABCCS	M1S100 M2CDMI
CDU function control flags	MABCCS	M1S100 M2CDUF
BITE test level	MBCCST	T1BITT
Warning message data and flag	MBCCST	M1S100
Geodetic datum ID number	MCXFOU	M1XFRM M2EFLD M2GPMG M2MGGP
System variable input data	MHDFCN	M2NCDF
Static/Dynamic mode flag	MNNVMC	N1MNVT
Operator selected SV data	MNOOPS	N1MSVT
Coordinate system flag	MPFIXD	M1NST2
SV search and Ephemeris flags	MQMSQC	M1NSVC M2RMDC
BITE request flag	MQMSQC	M1ST5M
NAV initialization data	MSBCCS	M1ST5M M2CDUF
Waypoint initialization data	MSBCCS	M2CDUF
Waypoint number	MWPCOD	M1NSWC
FTF update flags	MXFTFU	X1IT20
Memory read/write data	MXMRWD	M1S100 X1RPRT
RESTART flag	MXSRS	M1ST5M
Atmospheric correction flag	NBGOUT	N1MINT N1MNVT N2MAID N2MINC
RAM almanac flag	NVASEL	N1MSVT

Processing:

The Prompting Control Subroutine, M2PRMT, processes all operator input during a prompting session and during an ID prompting session. M1S100 calls M2PRMT when it recognizes the depression of the SEL button. During ID prompting M2PRMT controls the entry and display of one free text character in display 1. This character is used for an ID letter in radio transmission. During Prompting M2PRMT controls the choice of the major level class (type of input data), the minor level class (specific variable to be entered), and the entry and storage of valid data. Also during prompting memory may be displayed every second and modified on command.

M2PRMT calls M2NCDF to provide underscores, obtain data, and combine the data into an input word. M3LSBO and X3TIME are called during a Software RESTART to save memory and time. X1RPRT interfaces with M2PRMT to read from and write to memory.

Prompting is used to input specific values to MVUE variables. The basic steps in prompting are:

1. Choose the major level class (type of input data).
2. Choose the minor level class (specific variable to be changed).
3. Clear the input fields for data entry.
4. Supply data of the correct type, length, and magnitude.
5. Store the data in the MVUE.

The major level of prompting is obtained by entering SEL and a decimal digit. A three letter major level prompting code is displayed in displays 1, 2, and 3. After entering the major level, three options exist:

1. Enter (-) to terminate the session.

2. Enter (SEL) to advance the major level by 1 (cycling to level 1 after level 9)

3. Enter (.) to enter the minor level of prompting.

All other keystrokes result in an "&" being displayed in display 1.

The minor level of prompting chooses the specific variable to be input. Whenever a new minor level is obtained, it is checked against the maximum number of minor levels in that major level. If the maximum is exceeded, the major level is advanced by 1 (cycling to level 1 after level 9). A three letter minor level prompting code is displayed in displays 1, 2, and 3. Four options exist at a minor level of prompting:

1. Enter (SEL) which advances the major level of prompting by one and resets the minor level to one.

2. Enter (-) which terminates the session.

3. Enter (.) which advances the minor level by one.

4. Enter (CLR) which prepares for data entry.

All other keystrokes result in an "@" being displayed in display 1.

Depressing the CLR key starts the data entry process. If the particular data item chosen is a member of a logical input set (forced prompting set) that particular item must be the first member of the set. If it is not M2PRMT will return to the last major level of prompting. If the data item is the first item of a forced prompting set, or if it is not a forced prompting item, an underscore will appear in each field that is expecting data and data entry by the operator is expected.

Data entry consists of entering one character of data for each underscore. The data must be of the correct type; a "?" will appear

over an underscore that is being filled with data of the wrong type. CLR may be depressed at any time to replace all data with underscores. A "?" will appear in display 1 if the operator continues to enter data after all underscores have been replaced. M2PRMT will only consider the data that appears in the data field.

When the operator is satisfied with the data, he depresses ENT to store the data. If the data is not of the corect magnitude, underscores will reappear and the operator must enter data in the proper range. If the data is of the correct magnitude, it is stored in the appropriate MVUE system variable. If the data item if a member of a forced prompting set the next minor level's three letter prompting code will appear along with underscores for expected data entry. The CDU will clear after the last forced prompting item has been entered. If the data item is not a forced prompting item, a "$" appears in display 11 and the operator may enter:

1. (SEL) - to advance the major level by one.
2. (.) - To advance the minor level by one.
3. (.) - To terminate the session.

Except during free-text data input, depressing RAD terminates the prompting session with the CDU display extinguished.

Memory Read/Write is a special prompting mode. When the first minor level is entered by depressing (SEL), then (8), and then (.) M2PRMT will display "ADR" in displays 1, 2, and 3, ">" in display 6, and the last memory address read (or AAAA in none has been read) in displays 7, 8, 9, and 10. M2PRMT is now expecting depression of either the CLR or ENT buttons. Any other entry will result in a "?" in display 1. If ENT is depressed M2PRMT goes directly to MEMORY

Read. If CLR is depressed M2PRMT will provide four underscores in displays 7, 8, 9, and 10 and will expect four hexadecimal digits to be entered. When the digits are entered and ENT is depressed M2PRMT will perform Memory READ.

The contents of the address are obtained from X1RPRT and are displayed in the following format: "CNT" in displays 11, 12, and 13; ">" in display 16; and four hexadecimal digits (the memory contents) in displays 17, 18, 19, and 20. The operator now has three options:

1. Depress (-) to terminate the session.
2. Depress (.) to increment the address by two
3. Depress (CLR) to allow the operator to supply a new value for the memory location.

While the operator is making his decision, the memory contents are read and displayed about every two seconds. If the operator chooses to write to memory, four underscores appear in displays 17, 18, 19, and 20. Four hexadecimal digits are expected. After the operator depresses ENT to store the new memory content, the memory address is read so that the operator may verify the correct storage of his new value.

5.2.26 M2RMDC

Mnemonic: M2RMDC

Title: Receiver Mode and Ephemeris Control

Priority: N/A

Invoked By: M1NSVC

Invokes: M2EPHM, M2RMOD

Inputs:

Parameter	Data Set	Source
Receiver Status	MCSVST	M2RMOD
Navigation SV Number	MNPSVN	M1NST2
Operator Approval Ephemeris	MQMSQC	M1S100, M1ST5M
New SV Search	MQMSQC	M1S100, M1ST5M
Full Ephemeris Time Constant	MQSVSQ	Block Data
Altitude Hold SV	MVSVSQ	M1NSVC
SV Elevation Sequence	MVSVSQ	M1NS20, M1NSVC
Ephemeris Clock - TE	MVSVSQ	M2RMDC, M2RMOD
Number of SV's in Sequence	MVSVSQ	M2RMOD
Last 2 Values of MRCMOD	MVSVSQ	M2RMOD
Internal Ephemeris flag	MVSVSQ	M2EPHM
New or Full Ephemeris flag	MVSVSQ	M2EPHM
Last 2 SV'S Commanded by Rcvr	MVSVSQ	M1NSVC
CDUV Full Ephemeris flag	MVSVSQ	M2RMDC
Outer Loop has Run flag	MVSVSQ	M1NSVC
Ephemeris Data been Collected	MVSVSQ	M2EPHM

Outputs:

Parameter	Data Set	Destination
System Warning Message Semaphore	MBCCSF	M1NS20, M1NSVC, M1S100 M2CDUF, M2RMDC
System Warning Message Array		M1NS20, M1NSVC, M1S100 M2CDUF, M2RMDC
Number of Sources being Tracked	MNPSVN	M1NS20, M1NSVC
Delay Dropping Altitude Hold	MVSVSQ	M1NSVC
Altitude Hold is Taking Place	MVSVSQ	M1NSVC
CDUV Full Ephemeris flag	MVSVSQ	M2RMDC
Setting SV Search flag	MVSVSQ	M1NSVC
New SV Ephemeris Pointer	MVSVSQ	M2RMDC, M2EPHM
Outer Loop has Started	MVSVSQ	M1NSVC
SV Currently being Timed	MVSVSQ	M2RMOD
Ephemeris Update Timer flag	MVSVSQ	M2RMDC
New or Full Ephemeris flag	MVSVSQ	M2EPHM, M1NSVC, M2RMOD
Too Few SV's flag	MVSVSQ	M1NSVC
New SV Search is Underway	MVSVSQ	M1NSVC

SV for Ephemeris Update	MVSVSQ	M2EPHM
New SV Gains Comp. flag	MVSVSQ	M1NSVC

Processing:

M2RMDC is the receiver mode control for recording SV status of the last receiver acquisition, schedules ephemeris updating and handles new SV acquisition.

The receiver mode is saved and a new receiver mode is computed in M2RMOD. The following sections are executed depending on the saved receiver mode.

Receiver mode of 4 for C/A reacquisition. If the SV failed on C/A reacquisition, then recheck the status. If the status changed to 2, then check to see if that source was in altitude hold and drop altitude hold if it was. The normal ephemeris update control logic is then executed.

Receiver mode of 5 for record P status. If the reacquisition status is 4, then processing is the same as mode 8. If handover is being attempted or the signal has been lost, then recheck the status and proceed with normal ephemeris control. If reacquisition had timed out but is now good, then check if the source was in altitude hold and proceed with normal ephemeris control.

Receiver mode of 8 for new SV reacquisition. Check the status and if the SV was not acquired the first time, then process the normal ephemeris control. The following is used if SV was acquired. The timer and gains computed flags are cleared for the new source. If we are within 15 minutes of or in process of, collecting a full ephemeris, then schedule a full ephemeris update with the new source included and call M2EPHM. If not a full ephemeris, then check that the new ephemeris is operator approved and command ephemeris for the

new SV and call M2EPHM.

Normal ephemeris update control is processed in the following order. 1) If ephemeris is currently being updated, then call M2EPHM. 2) If full ephemeris not due, then return. 3) If full ephemeris collection is in progress, then set flags for new ephemeris and call M2EPHM. 4) If the ephemeris is operator approved, then command full ephemeris and call M2EPHM.

5.2.27 M2RMOD

Mnemonic: M2RMOD

Title: Receiver Mode and Ephemeris Control

Priority: N/A

Invoked By: M1NSVC, M2RMDC

Invokes: None

Inputs:

Parameter	Data Set	Source
Receiver Status of Last Reacq.	MCSVST	M2STAT
SV Replacement flag	MNSVSC	M1NSVC, M2RMOD
SV ID Pointer	MQMSQC	M1NS20, M1NSVC
Altitude Hold SV	MVSVSQ	M1NSVC
SV Elevation Sequence	MVSVSQ	M1NS20, M1NSVC
Ephemeris Data been Collected	MVSVSQ	M2EPHM
New or Full Ephemeris flag	MVSVSQ	M2EPHM
C/NO Measurement flag	MVSVSQ	M2NSVC
SV Pointer	MVSVSQ	M2NSVC
Number of SV's in Sequence	MVSVSQ	M1NSVC
Control flag for Setting SV	MVSVSQ	M1NSVC
Number of SV's in NAV	NMAPPL	N1MSVT
Aiding Array for SV's	NRAID	N2MAID

Outputs:

Parameter	Data Set	Destination
System Warning Message Semaphore	MBCCSF	M1NS20, M1NSVC, M1S100 M2CDUF, M2RMDC
System Warning Message Array		M1NS20, M1NSVC, M1S100 M2CDUF, M2RMDC
Status of Last Reacq.	MCSVST	M2RMOD, M2RMDC
Data Block Collection Status	MCTDBP	M1NS20
Number of Sources being Tracked	MNPSVN	NAV, M1NSVC
Replacement Reason	MNSVSC	N1MSVT
Receiver Command Mode	MRCOMD	R1XCCP
SV in Altitude Hold	MVSVSQ	M1NSVC
Altitude Hold Active flag	MVSVSQ	M1NSVC
SV Sequenced from High to Low	MVSVSQ	M2RMDC, M1NSVC, M2EPHM
Ephemeris Update Timer flag	MVSVSQ	M2RMDC
New or Full Ephemeris flag	MVSVSQ	M2RMDC, M2RMOD
FTF Init. flag for Ephmereis	MVSVSQ	M2EPHM
First Mode 7 for this SV	MVSVSQ	M2EPHM
Issue Iono Correction Command	MVSVSQ	M1NSVC
Outer Loop Started flag	MVSVSQ	M1NSVC
SV Replacement Array	MVSVSQ	M1NSVC

Number of SV's in Sequence	MVSVSQ	M1NSVC
Control flag for Setting SV	MVSVSQ	M1NSVC, M2RMOD
Timer and Control for SV's	MVSVSQ	M1NSVC, M2RMOD

Processing:

M2RMOD is responsible for setting the receiver mode, presenting the mode to the receiver and controls the timing for SV searching logic.

If the receiver is tracking the L2 signal, then set the command mode to 6, increment the timer if it is on and return. If not tacking the L2 signal, then the following sections are executed depending on the status of the last reacquisition.

Status of 1 for SV reacquired with P code and tracking. Set the receiver mode to 5, increment the timer if it is on and return.

Status of 2 for SV reacquired with C/A code and awaiting P code reacquisition or a status of 7 for new SV acquired in mode 8. If the maximum time allowed has not elasped, then do the same as status 1. If too much time has been used then do the following. Issue a warning message to the CDU. Decrement the number of SV's being tracked. Set altitude hold to true if the number of SV's is less than 4. If the C/NO value is greater than the threshold, then set the mode to 5 and the status to 13 else set the mode to 24 and the status to 11. Clear the timer and return.

Status of 3 for SV acquired but not reacquired. Turn the timer on and set the mode to 4 for C/A reacquisition. If the maximum time has not elaspe, then increment the timer and return. When the maximum time has been exceeded then decrement the number of sources, switch on altitude hold if needed, set the status to 12, clear the timer and return.

Status of 4 for SV failed to acquire the first time or status of

16 for new SV acquired in steady state but can not get ephemeris. Turn the timer on, set the mode to 8 and execute the SV replacement logic.

Status of 6 for SV failed to be acquired with P code. Turn the timer on execute the logic for status 2.

Status of 10 for SV failed to handover to P code in steady state. Set the time limit, turn the timer on and proceed with the code for status 2.

Status of 11 for reacquisition time out for receiver mode 24. Set the mode to 24, turn the timer on, set time limit and execute the SV replacement logic.

Status of 12 for C/A timeout. Set the mode to 4, turn the timer on, set the time limit and execute the SV replacement logic.

Status of 13 for reacquisition time out and good SNR. Set the mode to 5, turn the timer on, set the time limit and execute the SV replacement code.

Status of 14 for SV just set and no replacement found or status of 17 for SV just set and replacement found. Change the status from 14 to 15 or 17 to 4, set mode to 4 unless status was set to 4 then set mode to 8, decrement number of sources, decrement number of sources in sequence, set altitude hold if nessecary, clear the timers and return.

Status of 15 for SV has set, ignore measurements. Set the mode to 8 and return.

5.2.28 M2STAT

Mnemonic: M2STAT

Title: Receiver Status Update

Priority: N/A

Invoked By: M2RMDC

Invokes: none

Inputs:

Parameter	Data Set	Source
Navigation SV Number	MNPSVN	M1NST2
Success code	Parameter	M2RMDC
Failure code	Parameter	M2RMDC
Receiver Meas. Validity flag	RMMSGF	R1RMO

Outputs:

Parameter	Data Set	Destination
Status of Receiver Acquisition	MCSVST	M2RMOD

Processing:

M2STAT stores the success or failure code for the last acquisition in MCSTAT by the navigation SV ID, MNPSVI. Upon successful acquisition, the receiver validity flag, RMMVAL, will be negative. At that time the success code is stored in MCSTAT and the reacquisition times for that source, MVTPRA, are reset to zero. When RMMVAL is greater than or equal to zero a failure has occurred and the failure code is stored in MCSTAT.

5.2.29 M3CDUO

Mnemonic: M3CDUO

Title: CDU Output Service

Priority: N/A

Invoked By: M2CDMI

Invokes: none

Inputs:

Parameter	Data Set	Source
CRU Address for CDU	XACRMV	X9MVUE
CDU Data	N/A	Calling Program

Outputs:

Parameter	Data Set	Destination
CDU Data	N/A	CDU

Processing:

M3CDUO provides CDU output service for FORTRAN tasks. It sets the CRU base address to CDU output and outputs 16 bits of data pointed to by the calling program to the CDU. The calling sequence is as follows:

```
INTEGER*2 VAL
.
.
CALL M3CDUO(VAL)
```

5.2.30 M3LSBO

Mnemonic: M3LSBO

Title: Set Bit to One Service

Priority: N/A

Invoked By: M2PRMT, M2CDUF, M2CDMI, M1ST5M

Invokes: none

Inputs:

Parameter	Data Set	Source
CRU Address	N/A	Calling Program

Outputs:

Parameter	Data Set	Destination
CRU Data	N/A	CRU Line

Processing:

M3LSBO provides a FORTRAN callable service to set individual CRU lines to state one, corresponding to the assembly language instruction SBO. The calling sequence is as follows:

```
INTEGER*2 CRUADR
    .
    .
CALL M3LSBO(CRUADR)
```

5.2.31 M3LSBZ

Mnemonic: M3LSBZ

Title: Set Bit to Zero Service

Priority: N/A

Invoked By: M2PRMT, M2CDMI, M1NSDT

Invokes: none

Inputs:

Parameter	Data Set	Source
CRU Address	N/A	Calling Program

Outputs:

Parameter	Data Set	Destination
CRU Data	N/A	CRU Line

Processing:

M3LSBZ provides a FORTRAN callable service to set individual CRU lines to state zero, corresponding to the assembly language instruction SBZ. The calling sequence is as follows:

```
INTEGER*2 CRUADR
.
.
CALL M3LSBZ(CRUADR)
```

5.2.32 M30DHO

Mnemonic: M30DHO

Title: DHO Output Service

Priority: N/A

Invoked By: M2CDMI

Invokes: none

Inputs:

Parameter	Data Set	Source
DHO Data	N/A	Calling Program

Outputs:

Parameter	Data Set	Destination
DHO Data	N/A	DHO Port (MIS)

Processing:

M30DHO provides DHO output service for FORTRAN tasks. The DHO port is used to output data to the MVUE Instrumentation System (MIS). M30DHO sets the CRU base address to DHO output and outputs 16 bits of data pointed to by the calling program to the DHO port. The calling sequence is as follows:

```
INTEGER*2 VAL
.
.
CALL M30DHO(VAL)
```

5.2.33 M3RTIM

Mnemonic: M3RTIM

Title: Standby Timer Read Service

Priority: N/A

Invoked By: M1ST5M

Invokes: none

Inputs:

Parameter	Data Set	Source
Standby Timer Count	N/A	EIOM
CRU Address for stby Timer	XACRMV	X9MVUE

Outputs:

Parameter	Data Set	Destination
Standby Timer Count	N/A	R0 and R1 of Calling Task
Standby Timer Hold	N/A	EIOM

Processing:

M3RTIM provides standby timer read service for FORTRAN tasks. It issues a hold command to the standby timer and then reads 3 bytes of data. The data is left justified in registers 0 and 1 of the calling task, enabling the calling task to reference M3RTIM as an INTEGER*4 function. The calling sequence is as follows:

```
EXTERNAL M3RTIM
INTEGER*4 M3RTIM, X
.
.
```

```
X = M3RTIM(0)
```

5.2.34 M3STCR

Mnemonic: M3STCR

Title: CRU Read Bit Service

Priority: N/A

Invoked By: M1NSDT

Invokes: none

Inputs:

Parameter	Data Set	Source
CRU Address	N/A	Calling Program
CDU Data	N/A	CRU Line

Outputs:

Parameter	Data Set	Destination
CDU Data	N/A	RO of Calling Program

Processing:

M3STCR provides a CRU read service for FORTRAN tasks corresponding to the STCR instruction in assembly language. It sets the CRU base address to the address specified by the calling program, reads 1 bit of data and places it in the LSB register 0 of the calling program. This provides an INTEGER*2 FUNCTION linkage to the calling task. The calling sequence is as follows:

```
EXTERNAL M3STCR
INTEGER*2 M3STCR,X,CRUADR
```

```
X = M3STCR(CRUADR)
```

5.2.35 M3STIM

Mnemonic: M3STIM

Title: Standby Timer Initialization Service

Priority: N/A

Invoked By: M2CDMI

Invokes: none

Inputs:

Parameter	Data Set	Source
CRU Addr for Stby Timer	XACRMV	X9MVUE

Outputs:

Parameter	Data Set	Destination
Standby Timer Controls	N/A	EIOM

Processing:

M3STIM provides standby timer initialization service for FORTRAN tasks. It commands the following actions: (1) Hold timer (2) Clear timer (3) Arm timer and (4) Start timer. The calling sequence is as follows:

```
CALL M3STIM
```

5.2.36 M9DATA

Mnemonic: M9DATA

Title: Master State Subsystem Block Data

Priority: N/A

Invoked By: N/A

Invokes: None

Inputs: None

Outputs:

Parameter	Data Set	Destination
Data block processing constants	MDBCON	M2DBPR
Coordinate transform constants	MELIPS	M1XFRM M2EFLD M2GPMG M2MGGP M2MSLH
C/No filter constants	MGCNOK	M1CNSV
Number of MIS output words	MPIXUM	M2CDMI
SV sequence control constants	MQSVSQ	M1NSDT M1NSVC M2RMDC M2RMOD
Prompting control constants	MYPRNT	M1S100 M2CDMI M2CDUF M2NCDF M2PRMT

Processing:

M9DATA provides constants for the Master State Subsystem.

5.3 NAVIGATION SUBSYSTEM MODULE DESCRIPTIONS

The following subparagraphs provide module level descriptions for each of the modules which make up the Navigation Subsystem.

5.3.1 N1MINT

Mnemonic: N1MINT

Title: Navigation Initialization

Priority: 30 second, background

Invoked By: Executive

Invokes: N2MRNG, N2MFOT, N2MSCI, N2MSVE

Inputs:

Parameter	Data Set	Source
Warmstart Flag	MNBEGN	M1ST5M, M1S100
Number of Visible SV's	NMAPPL	N1MSVT
Nav SV/GT ID array	NGGSVP	N1MSVT, N2MSVS
RAM Almanac Data	MNRALM	N1MSVT, M2DBS3
Operator Input Time	NMSIFC	N1MMIT, M2CDUF
Current Week	NMSIFC	M2CDUF
Precision Time Command	MNBEGN	M1ST5M, M1S100
SV Ephemeris Flag	MNEPHM	M2DBS2
GT Ephemeris Flag	MNGTDS	M2DBS1
Rcvr Measurements	RNMEAF	R1RMO
User Position	NAGINR	N2MNEQ, N1MMIT, N1MSVT
Satellite Position	NGGSVP	N2MSVE
Speed of Light	NECNST	N9DATA
GPS Clock Bias	NAGINR	N1MINT, N2MSCI, N1MSVT
Outer Loop SV ID	MNPSVN	M1NST2
Inner Loop Alt Hold	MNAICN	M1NSVC, N1MMIT
SV Pos Comp Flag	NGGSVP	N1MINT, N1MSVT, N2MSVP
Fit Coeff Time	NGGSVP	N2MSVP
Fit Buffer Index	NGGSVP	N1MNVT, N1MSVT
GPS Clock Time	NAGINR	N2MSCI, N2MNEQ
Computed Range	NAGINR	N2MRNG
Satellite Position	NGGSVP	N2MRNG
User Velocity	NAGINR	N2MNEQ, N1MMIT, N1MINT
Range Bias	NAGINR	N2MNEQ, N1MMIT, N1MINT
Range-Rate Bias	NAGINR	N1MMIT, N1MINT
Filter Range Gains	NBGOUT	N2MCUP
Altitude	MNBEGN	M1S100, M1NST2
Atom Corr Usage Flag	NBGOUT	M2CDUF

Inner Loop SV ID	MNPSVN	M1NST2
Gain Comp Flag	NMINIT	N1MINT, M1NS20, N1MNFL

Outputs:

Parameter	Data Set	Destination
Outer Loop SV ID	MNPSVN	N1MINT, N2MSCI
Inner Loop SV ID	MNPSVN	N1MINT, N1MNVT, N1MMIT
Covariance Matrix	NBGOUT	N2MCPR, N2MCUP
User Velocity	NAGINR	N1MINT, N1MMIT, N2MRNG, N2MNEQ
Measurement Residuals	NBGOUT	N2MAID, N1MMIT
Range Bias	NAGINR	N1MNVT, N1MMIT, N2MSCI, N2MAID, N1MINT, N2MNEQ
Range-Rate Bias	NAGINR	N1MMIT, N1MINT, N2MNEQ, N2MAID
GPS Clock Bias	NAGINR	N1MINT, N2MSCI, N1MSVT
Meas Incorp Flag	NAGINR	N1MMIT
Inner Loop SV ID	NDGSYS	N2MSCI, N1MNVT, N1MMIT
Nav Precision Time Flg	NAGINR	N2MSVE
Orbit Comp Flag	NGGSVP	N2MSVE
SV ID for Orbit Comp	NGGSVP	N2MSVE, N1MSVT, N2MSVP, N2MSVS
SV Pos Comp Time	NGGSVP	N2MSVS, N2MSVP
Computed Range	NAGINR	N1MMIT, N1MINT, N2MINC, N2MRNG, N2MAID
User Time Bias	NAGINR	N1MINT
Precision Time Command	MNBEGN	N1MINT
SV Pos Comp Flag	NGGSVP	N2MSVP, N1MINT
Satellite Comp Time	NAGINR	N1MNVT, N1MSVT
SV Task Command	NGGSVP	N1MSVT, N1MNVT
SV ID for Range Calc	NDGSYS	N2MRNG, N1MMIT
SV Time at Rcvr Stop	NAGINR	N2MRNG, N1MINT, N1MMIT
SV Pos at Rcvr Stop	NGGSVP	N2MFOT
Filter State Vector	NCGIOU	N2MFOT
Outer Loop SV ID	NDGSYS	N1MMIT, N1MNFL, N2MCUP
Outer Loop Alt Hold	MNAICN	N1MNFL, N2MFOT, N2MCUP
Filter Range Gains	NCGIOU	N1MMIT
Atomospheric Corr	NAGINR	N1MNVT, N2MAID
Gain Complete Flag	NMINIT	M1NSDT
New SV Gain Comp Flag	NMINIT	M1NSVC
Acquisition Flag	NGGSVP	N2MSVS, N1MMIT, N2MAID, N2MSVP, N1MSVT
Gain Comp Flag	NMINIT	M1NS20, N1MINT

Processing:

This routine executes only during acquisition. It is deactivated after gains have been calculated for the last transmitter visible and remains inactive throughout steady state.

Upon activation this routine initializes the inner and outer loop pointers, the covariance matrix, the user's velocity state, the measurement residuals, and the range bias and bias rate states. The satellite clock corrections are computed using almanac clock correction data. If this is a warmstart, the range bias, bias rate, and clock corrections are not reinitialized.

After the first satellite has been acquired and ephemeris data collected, the initial estimate of the user's clock bias is computed based on the range measurements from the receiver and computed range using the position of the user input by the operator. The satellite clock corrections used in the calculation are computed in the module N2MSCI using ephemeris clock correction data, and the satellites position used in the calculation is computed in the module N2MSVE using ephemeris data.

For each SV , the measured range is computed by calling N2MSCI, the fit coefficients centered on the time of signal transmission are computed by N1MSVT (enabled by setting NGTIME to TRUE), the position of the satellite (to be used in the outer loop gains computation) is computed by calling N2MRNG, the filter gains are calculated by calling N2MFOT, the atomospheric correction is calculated, and the inner loop flags are set so that N1MMIT uses these gains to incorporate the measurement. Also at this time the gain complete flags are set. After the inner loop has completed, the cycle is repeated until all SV's have been processed.

5.3.2 N1MMIT

Mnemonic: N1MMIT

Title: Measurement Incorporation

Priority: 2 second foreground

Invoked By: Executive

Invokes: N2MRNG, N2MAID, N2MNEQ

Inputs:

Parameter	Data Set	Source
Meas. Incorp. Flag	NAGINR	N1MINT
Inner Loop SV ID	NDGSYS	N2MSCI, N1MINT, N1MNVT N1MMIT
Outer Loop SV ID	NDGSYS	N1MINT, N2MSCI
Acquisition Flag	NGGSVP	N1MSVT, N1MINT
Inner Loop Alt Hold	MNAICN	M1NSVC, N1MMIT
Fit coeff. Time	NGGSVP	N2MSVP
Fit Buffer Index	NGGSVP	N1MNVT, N1MSVT
SV ID for Range Calc	NDGSYS	N1MMIT, N1MINT, N2MAID
Receiver Measurements	RNMEAF	R1RMO
Clock Bias	NAGINR	N1MINT, N2MSCI, N1MSVT
Speed of Light	NECNST	N9DATA
GPS Clock Time	NAGINR	N2MSCI, N2MNEQ
Computed Range	NAGINR	N2MRNG
Rcvr Meas. Update	NAGINR	N2MSCI
User Position	NAGINR	N2MNEQ, N1MMIT, N1MSVT
Range to Centr of Earth	NBGOUT	N1MSVT, N2MAID
Measured Range	NAGINR	N2MSCI, N1MNVT
Filter Range Gains	NCGIOU	N1MINT, N1MNFL
Measurement Residuals	NBGOUT	N1MMIT
User Velocity	NAGINR	N2MNEQ, N1MMIT, N1MINT
Nav SV/GT ID array	NGGSVP	N1MSVT, N2MSVS
Freeze Count	NCGIOU	N1MMIT
SV's being Tracked	MNPSVN	M1NS20, M1NSVC
Range Bias	NAGINR	N2MNEQ, N1MMIT, N1MINT
Range-Rate Bias	NAGINR	N1MMIT, N1MINT
Filter Activ. Count	NAGINR	N1MNVT
Nav Cycle Count	NFITCN	N9DATA
Satellite Position	NGGSVP	N2MRNG
User Clock Time	NAGINR	N2MSCI, N2MNEQ
Nav Mode	MNNVMC	M1NST2
First Fix Flag	MPFIXD	M1NSVC, M1NST2
Pos. Accum. Flag	NAGINR	N1MMIT
User Position	NMSIFC	M2CDUF, N1MMIT
Chg in Static Ave Pos	NGGSVP	N1MMIT
Static Ave Pos at Strt	NGGSVP	N1MMIT
Aiding Command	MNAICN	M1NS20, M1NSVC, N2MAID

Inner Loop SV ID	MNPSVN	M1NST2, N1MMIT

Outputs:

Parameter	Data Set	Destination
Transition Matrix Terms	NDGSYS	N2MCPR
Process Noise Cov	NBGOUT	N2MCPR
Innovation Matrix	NBGOUT	None
Range Noise Vector	NBGOUT	N2MCUP
SV ID for Range Calc	NDGSYS	N2MRNG, N1MMIT
SV Time at Rcvr Stop	NAGINR	N1MMIT, N2MRNG, N1MINT
Computed Range	NAGINR	N2MRNG, N1MMIT, N1MINT, N2MINC, N2MAID
Measured Range	NAGINR	N2MSCI, N1MNVT, N1MMIT
Inner Loop Alt Hold	MNAICN	N1MINT, N1MMIT
Measurement Residuals	NBGOUT	N2MAID, N1MMIT
User Position	NAGINR	N1MMIT, N2MRNG, N1MINT, N2MNEQ, N2MAID, N1MSVT, N2MSVS
User Velocity	NAGINR	N1MINT, N1MMIT, N2MRNG, N2MNEQ
Freeze Count	NCGIOU	N1MMIT
Range Bias	NAGINR	N1MNVT, N1MMIT, N2MSCI, N2MAID, N1MINT, N2MNEQ
Range-Rate Bias	NAGINR	N1MMIT, N1MINT, N2MNEQ, N2MAID
SV Pos at Rcvr Stop	NGGSVP	N2MFOT
Filter State Vector	NCGIOU	N2MFOT
CDU Lock Out	NMSIFC	M2CDUF
Operator Input Time	NMSIFC	M2CDUF, N1MINT, N2MAID, N1MSVT
User Time	NMSIFC	M1NSDT, M1NST2
Static Ave Pos at Strt	NGGSVP	N1MMIT
Chg in Static Ave Pos	NGGSVP	N1MMIT
Pos Accum Flag	NAGINR	N1MMIT
User Position	NMSIFC	M1NST2, N1MMIT, N1MSVT
User Velocity	NMSIFC	M1NST2
Range Bias	NMSIFC	M1NSDT
Range-Rate Bias	NMSIFC	M1NSDT
Aiding Complete	MNAICN	M1NS20, N2MRNG
Iono Corr SV ID	MNPSVN	N2MSCI
Inner Loop SV ID	MNPSVN	N1MINT, N1MNVT, N1MMIT
Outer Loop SV ID	MNPSVN	N1MINT, N2MSCI
Inner Loop SV ID	NDGSYS	N2MSCI, N1MNVT, N1MMIT

Processing:

Upon activation this routine initializes the state transition matrix, the process noise covariance matrix, the innovation and range noise vectors. (The innovation vector is not currently used. If filter

adaptation were added, then it would be used.)

Upon normal entry a call is made to N2MRNG to compute geometric range. (If Nav is in altitude hold, the range to the center of the earth is computed from the current user's position, and the measured range is set to a value of the range to the center of the earth that was computed and saved at the time altitude hold was initiated or was computed from the altitude, latitude and longitude entered by the user.) Next the receiver data is checked for good range data. If it is good, the measurement residual is computed and the state is updated using the gains computed in the outer loop. A check is also made at this time to determine if it is necessary to freeze time, i.e., bypass the update of the range bias states.

If time is at a 24 second boundary, satellite position and user state is saved for use in the next execution of the filter outer loop. If the operator has commanded the stationary user mode, the users position is smoothed by a 30 second time constant exponential filter. The user state is then stored in the MCSS common for coordinate transformation and CDU output. A call to N2MNEQ propagates the state to the next two second boundary. If receiver aiding is commanded, N2MAID is called. The final function is to reset the inner loop flags.

5.3.3 N1MNFL

Mnemonic: N1MNFL

Title: Navigation Filter

Priority: 24 seconds, foreground

Invoked By: Executive

Invokes: N2MFOT

Inputs:

Parameter	Data Set	Source
Filter Range Gains	NBGOUT	N2MCUP
SV ID for NAV Filter	NDGSYS	N1MINT, N2MSCI
Meas. Residuals Squard	NCGIOU	N2MAID
Meters/P-chips conv.	NECNST	N9DATA
Sys. Model Bias Error	NFITCN	N9DATA

Outputs:

Parameter	Data Set	Destination
Gain Comp. Flag	NMINIT	M1NS20, N1MINT
Gain Replacement Flag	NCGIOU	N1MNFL
Filter Range Gains	NCGIOU	N1MMIT
Spher. Pos. Error Est	NMSIFC	M2CDUF
Outer Loop SV No.	MNPSVN	N1MINT, N2MSCI
Outer Loop Alt Hold	MNAICN	N1MNFL, N2MFOT, N2MCUP
New SV Gain Comp Flag	NMINIT	M1NSVC

Processing:

The filter task contains the control logic for the navigation filter. It calls N2MFOT which performs all the filter computations. Next it replaces the old gains being used by the measurement incorporation task with the new gains that were just calculated. It then computes an estimate of the uncertainty in the user's estimated position, sets the gain complete flags, and resets the outer loop flags.

5.3.4 N1MNVT

Mnemonic: N1MNVT

Title: Navigation Task

Priority: 2 second foreground

Invoked By: Executive

Invokes: N2MSCI, N2MINC

Inputs:

Parameter	Data Set	Source
DHO Flag	NMDHOB	M1DHRX
User Time at Start	NAGINR	N1MSVT
SV Task Command	NGGSVP	N1MNVT, N1MSVT, N1MINT
Satellite Comp. Time	NAGINR	N1MINT, N1MNVT, N1MSVT
Fit Buffer Index	NGGSVP	N1MNVT, N1MSVT
Nav Cycle Count	NFITCN	N9DATA
Filter Activ. Count	NAGINR	N1MNVT
Inner Loop SV ID	MNPSVN	M1NST2
Iono. Corr. SV ID	NDGSYS	N2MSCI, N2MINC
Inner Loop SV ID	NDGSYS	N2MSCI, N1MINT, N1MNVT, N1MMIT
Atom. Corr. Usage Flag	NBGOUT	M2CDUF
Measured Range	NAGINR	N2MSCI, N1MNVT
Atmos. Corr.	NAGINR	N2MINC, N1MINT

Outputs:

Parameter	Data Set	Destination
Fit Buffer Index	NGGSVP	N2MAID, N1MSVT, N2MSVP, N2MRNG N1MINT, N1MNVT, N1MMIT
Satellite Comp. Time	NAGINR	N1MNVT, N1MSVT
SV Task Command	NGGSVP	N1MSVT, N1MNVT
Filter Activ. Count	NAGINR	N1MMIT, N1MNVT
Inner Loop SV ID	NDGSYS	N2MSCI, N1MNVT, N1MMIT
Measured Range	NAGINR	N1MMIT, N1MNVT, N2MSCI

Processing:

Upon activation this routine fills and aligns the fit coefficient buffers in preparation for the beginning of steady state operation. Upon normal entry it checks for the two minute boundary, and when found, flips the fit buffer flag and activates the satellite task to

calculate new fit coefficients. It then controls the interfaces with the other subsystems by calling N2MSCI. When commanded, it then calculates the atmospheric corrections for a specific SV by calling N2MINC. As its final function, it corrects the range measurement by applying the atmospheric corrections.

5.3.5 N1MSVT

Mnemonic: N1MSVT

Title: Satellite

Priority: 2 minute background

Invoked By: Executive

Invokes: N2MSVS, N2MSVP

Inputs:

Parameter	Data Set	Source
User Position	NMSIFC	M2CDUF
Operator Input Time	NMSIFC	M2CDUF
MCSS Operator Select Flag	MNOPSG	M1S100
Operator Input SV/GT ID's	MNOPSG	M1S100
Warmstart Flag	MNBEGN	M1ST5M, M1S100
ROM Almanac	NNRALM	N9DATA
Almanac Select Flag	NVASEL	M2PRMT
Time Values	NAGINR	N1MSVT
Fit Coeff. Comp. Flag	NMINIT	M2EPHM
RAM Almanac Data	MNRALM	N1MSVT, M2DBS3
Fit Coefficients	NGGSVP	N2MSVP
NAV SV/GT ID Array	NGGSVP	N1MSVT
SV Replacement Flag	MNSVSC	M1NSVC, M2RMOD
SV Replacement ID	NGGSVP	N2MSVS
SV Replacement Reason	MNSVSC	M1NSVC, M2RMOD

Outputs:

Parameter	Data Set	Destination
User Position	NAGINR	N1MMIT, N2MRNG, N1MINT, N2MNEQ, N2MAID, N1MSVT, N2MSVS
User Time	NAGINR	N1MNVT, N2MSVP
Time for N1MSVT Computations	NAGINR	N1MNVT, N1MSVT
NAV SV/GT ID Array	NGGSVP	N1MINT, N2MSCI, N2MINC, N1MMIT, N2MAID, N2MRNG, N1MSVT, N2MSVP, N2MSVE
Number Of Visible SV's	NMAPPL	M1NS20, M1NSVC, N1MSVT, N2MSVS, N2MSVP, N1MINT
Acquisition Flag	NGGSVP	N1MMIT, N2MAID, N1MSVT, N2MSVS,

		N2MSVP
Range to Center of Earth	NBGOUT	N1MMIT
RAM Almanac	MNRALM	N1MSVT, N2MSVS, N2MSVE, N1MINT, N2MSCI
Elevation Array	NMAPPL	M1NSVC, M1NS20
Interpolation Time	NGGSVP	N2MSVS, N2MSVP, N1MSVT
Elevation Change Flag	NMAPPL	M1NSVC
MCSS/NAV Mode	MNSVSC	M1NSVC
Ephemeris Flag	MNEPHM	N2MSVE, N1MINT, N2MAID
Fit Coeff. Comp. Flag	NMINIT	M1NSVC
Clock Bias	NAGINR	N1MINT, N1MMIT, N2MSCI, N2MAID, N1MSVT
SV Setting Flag	MNSVSC	M1NSVC
SV Pos. Comp. Flag	NGGSVP	N2MSVP, N1MINT
SV Task Command	NGGSVP	N1MSVT, N1MNVT

Processing:

N1MSVT is activated prior to the first satellite being aquired. When activated, the constellation of satellites is selected by a call of N2MSVS or by operator inputs. The user position array is initialized with x, y, z position components input from Master Control and computed from operator input position. User time is initialized from operator inputs, an initial range to the center of the earth is computed, the acquisition flag is set, the NAV SV/GT ID array is filled, and the number of SV's that are visible is determined. N2MSVP is then called to compute the initial fit coefficients, and finally the MCSS/NAV mode flag is set.

During acquisition, N1MSVT is enabled by N1MINT so that the fit coefficients can be recomputed using ephemeris data after each SV is acquired. This is accomplished by calling N2MSVP.

During steady state this routine is flag driven. This flag is set every two minutes for normal execution. If a replacement of an SV is requested by Master State, this task calls N2MSVS which determines the

relacement SV. That SV is entered into the NAV SV/GT ID array, and its fit coefficients and clock bias are computed. The normal two minute execution begins by calling N2MSVP for the computation of fit coefficients for each SV that is visible. The range squared for each satellite is computed and used to detect any setting SV, and if one is found, this routine notifies Master State of this fact. As its final function, this routine sets the MCSS/NAV mode flag if a replacement was requested. This flag tells Master State if a replacement was found.

5.3.6 N2MAID

Mnemonic: N2MAID

Title: Receiver Aiding

Priority: N/A

Invoked By: N1MMIT

Invokes: N2MRNG

Inputs:

Parameter	Data Set	Source
Aiding Command	MNAICN	M1NS20, M1NSVC, N2MAID
RAM Almanac Data	MNRALM	N1MSVT, M2DBS3
Auto. Almanac Acq.	MABCCS	M2PRMT
Fit Coeff. Time	NGGSVP	N2MSVP
Fit Buffer Index	NGGSVP	N1MNVT, N1MSVT
Range Bias	NAGINR	N2MNEQ, N1MMIT, N1MINT
Speed of Light	NECNST	N9DATA
Clock Bias	NAGINR	N1MINT, N2MSCI, N1MSVT
Computed Range	NAGINR	N2MRNG
Operator Input Time	NMSIFC	N1MMIT, M2CDUF
GPS Clock Time	NAGINR	N2MSCI, N2MNEQ
Atmospheric Correction	NAGINR	N2MINC, N1MINT
Atm. Corr. Usage Flag	NBGOUT	M2CDUF
Computed Range-Rate	NAGINR	N2MRNG
Range-Rate Bias	NAGINR	N1MINT, N1MMIT
Acquisition Flag	NGGSVP	N1MSVT, N1MINT
Rcvr Measurements	RNMEAF	R1RMO
NAV SV/GT ID Array	NGGSVP	N1MSVT, N2MSVS
SV Ephemeris Flag	MNEPHM	M2DBS2
GT Ephemeris Flag	MNGTDS	M2DBS1
Fit Coeff. Comp. Flag	NMINIT	M2EPHM
Measurement Residuals	NBGOUT	N1MMIT
Measurement Counter	NCGIOU	N2MAID
Altitude Hold SV	MVSVSQ	M1NSVC
Filter Convergence	NMINIT	N2MAID
SV's being Tracked	MNPSVN	M1NS20, M1NSVC
Range to C of E Flag	NCGIOU	N2MAID
User Position	NAGINR	N2MNEQ, N1MMIT, N1MSVT
Alt. Correction Data	NMSIFC	M2CDUF
Meters/P-chips Conv.	NECNST	N9DATA
Orig. Range to C of E	NBGOUT	N1MSVT
Range-Rate Acceleration	NAGINR	N2MRNG

Outputs:

Parameter	Data Set	Destination
Self-Aiding Flag	NMINIT	M1NSVC
SV ID for Range Calc.	NDGSYS	N2MRNG, N1MMIT
SV Time at Rcvr Stop	NAGINR	N2MRNG, N1MINT, N1MMIT
Measurement Counter	NCGIOU	N2MAID
Range to C of E Flag	NCGIOU	N2MAID
Meas. Residuals Squard	NCGIOU	N1MNFL
Filter Convergence	NMINIT	M1NSVC, N2MAID
Excess. Osc. Bias	NMSIFC	M1NSDT
Range - Center of Earth	NBGOUT	N1MMIT
Alt. Correction Data	NMSIFC	N2MAID
Aiding Command	MNAICN	N2MAID, N1MMIT
Rcvr Aiding Data	NRAIDF	R1XCCP
Precision Time Data	NRTIMF	R1XCCP

Processing:

This routine computes the aiding required by the receiver subsystem to find the signal from the satellite. Two distinct types of aiding are provided - Navigation Aiding and Self Aiding. Navigation Aiding computes range and range rate based on the estimated state of the user and the computed position and velocity of the satellite or ground transmitter. Self Aiding computes range and range rate based on an extrapolation of the last receiver measurement to the time of the next signal acquisition.

N2MAID first determines the time for which aiding is required which is 140 milliseconds past the next 2 second boundary. The module N2MRNG is then called to compute satellite range, range rate, and range acceleration. Navigation Aiding is this computed range and range rate scaled to units expected by the receiver. Navigation Aiding is sent to the receiver if in acquisition mode, or the filter is converged in steady state, or the signal for a new

SV is being acquired in steady state.

If the above conditions do not hold, then Self Aiding is computed using the receiver measurements. Self Aiding is also used if the ephemeris data has not been collected or if ephemeris data has been collected but the fit coefficients have not been computed yet.

In addition to computing aiding data, N2MAID contains logic for several other miscellaneous tasks. By looking at the measurement validity flags a determination of the number of satellites being tracked is made, and a flag is set for computing range to the center of the earth if less than 4 satellites are being tracked. The average measurement residual is computed to determine filter convergence and for use by N1MNFL in computing the estimated user position uncertainty. A check for excessive oscillator is made by comparing the range bias rate state with a threshold of 10 meters/sec.

The receiver also requires as part of the aiding data the time of the last 1.5 second satellite clock epoch, the bias between the user's clock and the satellite clock, and the user's 20 millisecond clock epoch which corresponds with the last satellite 1.5 second epoch. This is computed and stored, and the aiding flag is zeroed to indicate completion.

5.3.7 N2MCPR

Mnemonic: N2MCPR

Title: Covariance Propagation

Priority: N/A

Invoked By: N2MFOT

Invokes: None

Inputs:

Parameter	Data Set	Source
Adap. Proc. Noise FF	NCGIOU	Executive
Velocity Variances	NFITCN	N9DATA
Proc.Noise Cov.Matrix	NBGOUT	N1MMIT
Covariance Matrix	NBGOUT	N1MINT, N2MCPR, N2MCUP
Transition Matrix Terms	NDGSYS	N1MMIT

Outputs:

Parameter	Data Set	Destination
Covariance Matrix	NBGOUT	N2MCPR, N2MCUP

Processing:

This routine propagates the Kalman covariance using the U-D factorization procedure. It computes the level of process noise, uses the U-D factorization procedure (storing intermediate results in the lower triangular matrix), adds in the process noise covariance matrix, and places the final computation in the upper triangular matrix.

5.3.8 N2MCUP

Mnemonic: N2MCUP

Title: Covariance Matrix Update

Priority: N/A

Invoked By: N2MFOT

Invokes: None

Inputs:

Parameter	Data Set	Source
H-matrix	NBGOUT	N2MFOT
Covariance Matrix	NBGOUT	N1MINT, N2MCPR, N2MCUP
Outer Loop Alt. Hold	MNAICN	M1NSVC, N1MINT, N1MNFL
Range Noise Vector	NBGOUT	N1MMIT
DHO Covariance Flag	NMDHOB	N2MCUP

Outputs:

Parameter	Data Set	Destination
Innovation Matrix	NBGOUT	None
Covariance Matrix	NBGOUT	N2MCPR, N2MCUP
Filter Range Gains	NBGOUT	N1MINT, N1MNFL
DHO Covariance Flag	NMDHOB	M1DHRX, N2MCUP
DHO Covariance Buffer	NMDHOB	M1DHRX

Processing:

This routine performs an update by converting the a priori covariance to its a posteriori state based on a measurement input. This is done by using the U-D matrix factors instead of the covariance matrix directly. The range innovation factor is calculated for use in forming the sum of the normalized residuals. The Kalman gain matrix is then computed and the error covariance is saved for direct handover.

5.3.9 N2MFOT

Mnemonic: N2MFOT

Title: Navigation Filter Output

Priority: N/A

Invoked By: N1MINT, N1MNFL

Invokes: N2MCPR, N2MCUP

Inputs:

Parameter	Data Set	Source
Outer Loop Alt Hold	MNAICN	M1NSVC, N1MINT, N1MNFL
Filter State Vector	NCGIOU	N1MMIT, N1MINT
SV Pos. at Rcvr Stop	NGGSVP	N1MMIT, N1MINT

Outputs:

Parameter	Data Set	Destination
H-matrix	NBGOUT	N2MCUP

Processing:

This routine performs the control logic necessary to compute the propagated value of the covariance and the filter gains. It calls N2MCPR to propagate the error state covariance forward to the current time. It computes the range and geometry vector (H-matrix) for the current outer loop SV. And finally it updates the covariance and calculates the range gains by calling N2MCUP.

5.3.10 N2MINC

Mnemonic: N2MINC

Title: Atomospheric Correction

Priority: N/A

Invoked By: N1MNVT

Invokes: None

Inputs:

Parameter	Data Set	Source
Ionospheric Correction	NAGINR	N2MINC
Atom Corr SV ID	NDGSYS	N2MINC, N2MSCI
Nav SV/GT ID array	NGGSVP	N1MSVT, N2MSVS
Rcvr Measurements	RNMEAF	R1RMO
Rcvr L2 Measurements	RNIONF	R1RMO
Computed Range	NAGINR	N2MRNG
Altitude	MNBEGN	M1S100, M1NST2
Atom Corr Usage	NBGOUT	M2CDUF

Outputs:

Parameter	Data Set	Destination
Atomospheric Correction	NAGINR	N1MNVT, N2MAID
Ionospheric Correction	NAGINR	N2MINC
Atom Corr SV ID	NDGSYS	N2MINC, N1MNVT, N2MSCI

Processing:

This routine computes the ionospheric and tropospheric corrections to the measured range for a given SV using the measured ranges from the high (L1) and low (L2) frequencies. If either of these measurements is flagged as being bad, only the troposheric correction is calculated. In that case the previously calculated ionospheric correction for that SV will be used. The ionospheric corrections are filtered and bounded, and the total atomospheric correction is bounded.

5.3.11 N2MNEQ

Mnemonic: N2MNEQ

Title: State Equations Propagation

Priority: N/A

Invoked By: N1MMIT

Invokes: None

Inputs:

Parameter	Data Set	Source
Nav Mode	MNNVMC	M1NST2
GPS Clock Time	NAGINR	N2MSCI, N2MNEQ
User Clock Time	NAGINR	N2MSCI, N2MNEQ
Range Bias	NAGINR	N2MNEQ, N1MMIT, N1MINT
Range-Rate Bias	NAGINR	N1MINT, N1MMIT
Transition Matrix Terms	NDGSYS	N1MMIT
User Position	NAGINR	N2MNEQ, N1MMIT, N1MSVT
User Velocity	NAGINR	N2MNEQ, N1MMIT, N1MINT

Outputs:

Parameter	Data Set	Destination
User Position	NAGINR	N1MINT, N2MRNG, N1MINT, N2MNEQ, N2MAID, N1MSVT, N2MSVS
User Velocity	NAGINR	N1MINT, N1MMIT, N2MRNG, N2MNEQ
Range Bias	NAGINR	N1MNVT, N1MMIT, N2MSCI, N2MAID, N1MINT, N2MNEQ
GPS Clock Time	NAGINR	N1MINT, N1MMIT, N2MNEQ, N2MAID
User Clock Time	NAGINR	N1MMIT, N2MNEQ

Processing:

This routine propagates the navigation equations of motion. Upon entry the navigation mode is checked, and if stationary, the user velocity is zeroed. The state propagation (for user position, user velocity, and range bias) is then performed. Lastly, time is propagated forward for the case when receiver measurements are not

received.

5.3.12 N2MRNG

Mnemonic: N2MRNG

Title: Range Computation

Priority: N/A

Invoked By: N1MMIT, N2MAID

Invokes: None

Inputs:

Parameter	Data Set	Source
SV ID for Range Calc	NDGSYS	N1MMIT, N1MINT, N2MAID
SV Time at Rcvr Stop	NAGINR	N1MMIT, N2MAID, N1MINT
Fit Coefficients	NGGSVP	N2MSVP
Nav SV/GT ID Array	NGGSVP	N1MSVT, N2MSVS
Computed Range	NAGINR	N2MRNG
Earth Rotation Rate	NECNST	N9DATA
Satellite Position	NGGSVP	N2MRNG
User Position	NAGINR	N2MNEQ, N1MMIT, N1MINT
Aiding Complete	MNAICN	N1MMIT
User Velocity	NAGINR	N2MNEQ, N1MMIT, N1MINT
Fit Buffer Index	NGGSVP	N1MNVT, N1MSVT
Computed Range-Rate	NAGINR	N2MRNG
Range-Rate Acceleration	NAGINR	N2MRNG

Outputs:

Parameter	Data Set	Destination
Satellite Position	NGGSVP	N1MMIT, N1MINT, N2MRNG
Computed Range	NAGINR	N1MMIT, N1MINT, N2MINC N2MRNG, N2MAID
Computed Range-Rate	NAGINR	N2MAID, N2MRNG
Range-Rate Acceleration	NAGINR	N2MAID

Processing:

This routine computes the user to satellite range. In computing the range the satellite position at the receiver stop command is calculated and corrected due to the earth's rotation. The computed range-rate and the range-rate acceleration are also computed in this routine.

5.3.13 N2MSCI

Mnemonic: N2MSCI

Title: NAV/MCSS/RCVR Interface Subtask

Priority: N/A

Invoked By: N1MNVT

Invokes: None

Inputs:

Parameter	Data Set	Source
Outer Loop SV ID	MNPSVN	M1NST2
Iono Corr. SV ID	MNPSVN	M1NST2
Iono Corr. SV ID	NDGSYS	N2MSCI, N2MINC
Inner Loop SV ID	NDGSYS	N2MSCI, N1MINT, N1MNVT, N1MMIT
Rcvr Aiding Data	NRAIDF	N2MAID
Nav SV/GT ID Array	NGGSVP	N1MSVT, N2MSVS
Rcvr Measurements	RNMEAF	R1RMO
GPS Clock Bias	NAGINR	N1MINT, N2MSCI, N1MSVT
Speed of Light	NECNST	N9DATA
Range Bias	NAGINR	N2MNEQ, N1MMIT, N1MINT
SV Time Data	MNTCDS	M2DBS1
RAM Almanac Data	MNRALM	N1MSVT, M2DBS3
Current Week	NMSIFC	M2CDUF
Measured Range	NAGINR	N2MSCI, N1MNVT

Outputs:

Parameter	Data Set	Destination
Iono Corr. SV ID	NDGSYS	N2MINC, N1MNVT, N2MSCI
Outer Loop SV ID	NDGSYS	N1MMIT, N1MNFL, N2MCUP
Inner Loop SV ID	NDGSYS	N2MSCI, N1MNVT, N1MMIT
Rcvr Meas. Update Flag	NAGINR	N1MMIT
Measured Range	NAGINR	N1MMIT, N1MNVT, N2MSCI
User Time	NMSIFC	M1NSDT, M1NST2
GPS Clock Time	NAGINR	N1MINT, N1MMIT, N2MNEQ, N2MAID
User Clock Time	NAGINR	N1MMIT, N2MNEQ
SV Time Data Status	MNTCDS	N2MSCI
GPS Clock Bias	NAGINR	N2MSCI, N1MMIT, N1MINT, N2MAID N1MSVT

Processing:

This routine establishes the interface between the three (NAV/MCSS/RCVR) subsystems. It analyzes receiver measurements for

goodness. If good, it calculates the measured range and sets the User and GPS clock times. It also computes the SV/GT clock correction terms utilyzing the appropriate ephemeris or almanac data and corrects the measured range using these terms.

5.3.14 N2MSVE

Mnemonic: N2MSVE

Title: SV Positions Computations

Priority: N/A

Invoked By: N1MINT, N2MSVS, N2MSVP

Invokes: None

Inputs:

Parameter	Data Set	Source
NAV Precision Time Flag	NAGINR	N1MINT
Orbit Comp. Flag	NGGSVP	N2MSVP, N2MSVS
NAV Replacement Flag	NGGSVP	N2MSVS
NAV SV/GT ID Array	NGGSVP	N1MSVT, N2MSVS
SV ID for Orbit Comp.	NGGSVP	N2MSVS, N2MSVP
Ephemeris Flag	MNEPHM	M2DBS2
RAM Almanac Data	MNRALM	N1MSVT, M2DBS3
Current Week	NMSIFC	M2CDUF
SV Pos. Comp. Time	NGGSVP	N2MSVP, N2MSVS
GT Almanac Data	NECNST	N9DATA
GT Ephemeris Data	MNGTDS	M2DBS1

Outputs:

Parameter	Data Set	Destination
Ephemeris Flag	MNEPHM	N1MINT, N2MAID
Satellite Position	NGGSVP	N2MSVS, N2MSVP
GT Ephemeris Flag	MNGTDS	N1MINT, N2MAID

Processing:

When called by the satellite position subtask or by the satellite selection subtask, this routine calculates the SV/GT position at three different time points. When called during acquisition by the satellite selection subtask or the NAV initialization task, it calculates the SV/GT position at only one time point.

If the position coordinates are required for a ground transmitter, the GT status flag is checked. If not set, stored almanac

data is used for the position. If set, processed ephemeris data is used for the position.

If the position coordinates are required for a satellite, computations are performed using either ephemeris or almanac data depending upon whether the ephemeris flag is set or not. The position is computed by using Keppler's functional iteration.

5.3.15 N2MSVP

Mnemonic: N2MSVP

Title: Satellite Position

Priority: N/A

Invoked By: N1MINT, N1MSVT

Invokes: N2MSVE

Inputs:

Parameter	Data Set	Source
No. of Visible SV's	NMAPPL	N1MSVT
Acquisition Mode	NGGSVP	N1MINT, N1MSVT
Fit Buffer Index	NGGSVP	N1MNVT, N1MSVT
SV Pos. Comp. Flag	NGGSVP	N1MINT, N1MSVT
Interpolation Time	NGGSVP	N1MSVT
Fit Coeff. Comp. Flag	NMINIT	M2EPHM
NAV SV/GT ID Array	NGGSVP	N1MSVT, N2MSVS
Satellite Position	NGGSVP	N2MSVE
User Time at Start	NAGINR	N1MSVT

Outputs:

Parameter	Data Set	Destination
Orbit Comp. Flag	NGGSVP	N2MSVE
SV Pos. Comp. Time	NGGSVP	N2MSVE
SV ID for Orbit Comp.	NGGSVP	N2MSVE
Fit Coefficients	NGGSVP	N2MRNG, N1MSVT
Fit Coefficient Times	NGGSVP	N1MINT, N1MMIT, N2MAID
SV Pos. Comp. Flag	NGGSVP	N1MINT

Processing:

For new satellites being acquired (either during acquisition or for a new replacement) this subtask fills both buffers of the fit coefficients. These coefficients are calculated for the present time and for the next two minute time frame. N2MSVE is called to compute the satellite position at each of these times. In steady state the only difference is that one buffer of fit coefficients, for the next two minute time frame, is calculated.

5.3.16 N2MSVS

Mnemonic: N2MSVS

Title: Satellite Selection

Priority: N/A

Invoked By: N1MSVT

Invokes: N2MSVE

Inputs:

Parameter	Data Set	Source
Interpolation Time	NGGSVP	N1MSVT
RAM Almanac Data	MNRALM	N1MSVT, M2DBS3
User Position	NAGINR	N1MSVT
Satellite Position	NGGSVP	N2MSVE
Auto. Almanac Acq.	MABCCS	M2PRMT

Outputs:

Parameter	Data Set	Destination
SV Pos. Comp. Time	NGGSVP	N2MSVP, N2MSVE
Orbit Comp. Flag	NGGSVP	N2MSVE
SV ID for Orbit Comp.	NGGSVP	N2MSVE
No. of Visible SV's	NMAPPL	M1NS20, M1NSVC, N1MINT, N2MSVS, N2MSVP, N1MSVT
NAV SV/GT ID array	NGGSVP	N1MINT, N2MSCI, N2MINC, N1MMIT, N2MAID, N2MRNG, N1MSVT, N2MSVP, N2MSVE
Replacement SV ID	NGGSVP	N2MSVE, N1MSVT
NAV Replacement Flag	NGGSVP	N2MSVE

Processing:

During acquisition the range squared is computed for all SV's for which almanac is stored. The satellites position is computed by calling N2MSVE. This routine then positions the visible SV's highest to lowest in the sky and fills the NAV SV/GT ID array with the ordered SV's. In the automatic almanac aquisition mode the NAV SV/GT ID array is totally filled - first with the highest to lowest, and then with the remaining ID's. The total number of SV's visible is then stored.

During steady state the satellite selection subtask finds the range squared (using two different times) of all SV's not being used. It uses these values to determine if each of those SV's is rising or setting. The rising SV's and the setting SV's are sorted according to their range squared (highest to lowest). This routine then chooses the lowest rising SV or the highest setting SV with priority on the former. The SV ID is then returned by this subtask. If no such SV is available, an ID of 0 is returned.

5.3.17 N9DATA

Mnemonic: N9DATA

Title: Nav Block Data

Priority: N/A

Invoked By: Executive

Invokes: None

Inputs: None

Outputs:

Parameter	Data Set	Destination
Nav global constants	NECNST	N1MMIT, N2MAID, N2MRNG, N2MSVE, N1MNFL, N1MINT, N2MSCI
Nav intratask constants	NFITCN	N1MMIT, N1MNVT, N1MNFL, N2MCPR
ROM Almanac Data	NNRALM	N1MSVT

Processing:

This module provides BLOCK DATA values for Nav ROM areas.

5.4 EXECUTIVE SUBSYSTEM MODULE DESCRIPTIONS

The following subparagraphs provide module level descriptions for the principle modules which make up the Executive Subsystem.

5.4.1 ATAN2

Mnemonic: ATAN2

Title: Arctangent

Priority: Reentrant utility

Invoked by: N1XFRM, N2WPCM

Invokes: X3ERR, F"RGMY2, F"RITP, F"XRER

Inputs: X, Y from argument list

Parameter	Source
Argument passed (X)	Calling subprogram
Argument passed (Y)	Calling subprogram

Outputs: ATAN2

Parameter	Destination
Arctangent of X/Y in radians (ATAN2)	Calling subprogram

Processing:

ATAN2 computes the arctangent of the value X/Y and returns it as the value ATAN2. It requires the floating point arithmetic unit. X, Y, and ATAN2 must all be declared REAL*4. ATAN2 will log an error if X and Y are both equal to zero. The range of returned values is -PI to PI.

5.4.2 COS

Mnemonic: COS

Title: Cosine Function

Priority: Reentrant utility

Invoked by: NAV and Master State Subsystem

Invokes: X3ERR, F"RGMY, F"RITP, F"XRER

Inputs: X from argument list

Parameter	Source
Input angle in radians (X)	Calling subprogram

Outputs: COS

Parameter	Destination
Cosine of specified angle	Calling subprogram

Processing:

COS computes the cosine of a given angle X in radians. COS and X must be declared REAL*4. The range of returned values is -1 to 1. COS will log an error if X is outside the range -4*PI to 4*PI.

5.4.3 EASHFT

Mnemonic: EASHFT

Title: Extended Integer Arithmetic Shift

Priority: None (Executive service routine)

Invoked by: M2DBS1, M2DBS2, M2DBS3, M2MOVE

Invokes: X3ERRA

Inputs: From data set XIMSK, from argument list

Parameter	Source
Input number (NUMBER)	Calling subprogram
Shift count (ISHIFT)	Calling subprogram
Interrupt mask (XIMSKS)	XIMSK

Outputs:

Parameter	Destination
Shifted number	Calling subprogram

Processing:

EASHFT is a utility that performs an arithmetic shift on an extended integer argument. Passed as inputs are the number to be shifted and the shift count. Interrupts of level 6 and below are masked off. If the shift count is greater than 0, the number is shifted to the left and vice versa. An error is logged if the absolute value of the shift count is > 15 or if the sign bit changes during shifting. The shifted value is returned in registers 0 and 1 of the calling program.

5.4.4 IASHFT

Mnemonic: IASHFT

Title: Integer Arithmetic Shift

Priority: None (Executive service routine)

Invoked by: M2DBS3

Invokes: X3ERRA

Inputs: From data set XIMSK; NUMBER, ISHIFT from argument list

Parameter	Source
Input number (NUMBER)	Calling subprogram
Shift count (ISHIFT)	Calling subprogram
Interrupt mask (XIMSKS)	XIMSK

Outputs:

Parameter	Destination
Shifted number	Calling subprogram

Processing:

IASHFT is a utility that performs an arithmetic shift on an integer argument. Passed as inputs are the number to be shifted and the shift count. If the shift count is > 0, the number is shifted to the left and vice versa. An error is logged if the absolute value of the shift count is > 15 or if the sign bit changes during shifting. The shifted value is returned in register 0 of the calling program.

5.4.5 SIN

Mnemonic: SIN

Title: Sine Function

Priority: Reentrant utility

Invoked by: NAV and Master State Subsystems

Invokes: X3ERR, F"RGMY, F"RITP, F"XRER

Inputs: X from argument list

Parameter	Source
Input value (X)	Calling subprogram

Outputs: SIN

Parameter	Destination
Returned value of sin(X) (SIN)	Calling subprogram

Processing:

SIN computes an approximation to sin (X). SIN and X are declared REAL*4. Output values for SIN are in the range -1 to 1. SIN will log an error if the input value is outside the range -4*PI to 4*PI.

5.4.6 X3ACT

Mnemonic: X3ACT

Title: Process activate utility

Priority: None (executive service routine)

Invoked by: X1IPOW, M1CMSC, N1INIT, R1AID, R1MRC, R1PCK, R1RNG, R1RRM, R1SRC

Invokes: X3ERRA

Inputs: From data sets XOPRC, XOLEV, XOTSK, XACRU, XIMSK, XWORK, XDATA, XINT, XCOUNT; from argument list ZOYYYY, RNUM

Parameter	Source
X3ACT workspace (XWORKS)	XWORK
Non-error interrupt mask (XIMSKE)	XIMSK
Pointer to XLEVEL block (OTSKPL)	XOTSK
Pointer to XPROC block (OTSKPR)	XOTSK
Maximum number of rcvrs (OTSKMC)	XOTSK
Length of proc block (PRCBLK)	XOPRC
Pointer to next process in same priority (OPRCNP)	XOPRC
Pointer to previous process in same priority (OPRCPP)	XOPRC
Pointer to first process in this priority (OLEVPF)	XOLEV
Entry point to task (OTSKEP)	XOTSK
FTF unit from which priority is formed (OLEVFU)	XOLEV
Process status (OPRCST)	XOPRC
CRU address for interrupt clear (XACRUC)	XACRU
CRU address for interrupt enable/disable (XACRUE)	XACRU
Pointer to task block (ZOYYYY)	Calling program
Receiver number (if any)	Calling program

Outputs: To data sets XOPRC, XCOUNT

Parameter	Destination
Pointer to next process in this priority (OPRCNP)	XOPRC
Pointer to previous process in this priority (OPRCPP)	XOPRC
Process program counter	XOPRC

Process workspace pointer	XOPRC
1 millisecond epoch	XCOUNT

Processing:

X3ACT is designed to place a designated task into the process table corresponding to its assigned priority. From information contained in the task block (priority level pointer, process pointer, max number of concurrent processes, and task entry point), X3ACT inserts the task into the process block for its priority. The process block is a doubly linked list which is pointed to by the variable OLEVPF. The process block contains, for each entry, a pointer to the preceding and succeeding tasks in the priority and the tasks workspace pointer, program counter and status register.

Receiver tasks are handled differently. First, the process block is of variable size and must be computed. Also, the receiver number is passed as an extra argument. If this receiver number exceeds the maximum, an error is logged. If the task to be activated is the 1 ms epoch task, the 1 ms interrupt is cleared, enabled, and the 1 ms epoch count is cleared.

In addition to the case cited above, errors are also logged if the requested task is already active, or if more than two arguments are passed to X3ACT.

5.4.7 X3CANC

Mnemonic: X3CANC

Title: Receiver process deactivation

Priority: None (executive service routine)

Invoked by: R1AID, R1MRC, R1PCK, R1RNG, R1RRM, R1SRC

Invokes: X3ERRA

Inputs: From data sets XOPRC, XOLEV, XOTSK, XACRU, XIMSK, XINT, XWORK; from argument list ROYYYY, RNUM

Parameter	Source
Pointer to task block (ROYYYY)	Calling subprogram
Receiver number (RNUM)	Calling subprogram
Interrupt mask (XIMSKE)	XIMSK
X3CANC workspace (XWORKS)	XWORK
Pointer to level block (OTSKPL)	XOTSK
Pointer to process block (OTSKPR)	XOTSK
FTF on which process was constructed (OLEVFU)	XOLEV
Pointer to next process in priority (OPRCNP)	XOPRC
Pointer to previous process in priority (OPRCPP)	XOPRC
CRU address to clear interrupts (XACRUC)	XACRU
CRU address to enable/disable interrupts (XACRUE)	XACRU

Outputs:

Parameter	Destination
Bit map of enabled interrupts (XIENAB)	XINT
Pointer to next process in priority (OPRCNP)	XOPRC
Pointer to previous process in priority (OPRCPP)	XOPRC

Processing:

X3CANC provides the means for process deactivation for the receiver subsystem. It removes the cancelled subprogram's process block from the priority level linked list. If the cancelled task is a 1-ms task, the 1-ms interrupt is disabled, cleared, and removed from

the bit map.

X3CANC will log an error if more than two arguments are passed, or if the receiver number passed is greater than that allowed.

5.4.8 X3ERR, X3ERRA

Mnemonic: X3ERR, X3ERRA

Title: Error processing

Priority: None (executive service routine)

Invoked by: Several

Invokes: X3ERR invokes X3ERRA

Inputs: From data sets XIMSK, XHOME

Parameter	Source
Interrupt mask for all interrupts (XIMSKO)	XIMSK
Subsystem ID (XHOMSU)	XHOME
20 ms time mark -- second word (XC0022)	XCOUNT
Next location in error buffer to be filled (XEPTRF)	XERROR
Location following last word retrieved (XEPTRE)	XERROR
First word in error buffer (XEBUFS)	XERROR
Location following last word in error buffer (XEBUFE)	XERROR
Number of errors dropped (XEDROP)	XERROR

Outputs:

Parameter	Destination
Next word in error buffer to be filled (XEPTRF)	XERROR
Number of errors dropped (XEDROP)	XERROR

Processing:

X3ERR and X3ERRA perform the error processing function for the three subsystems. X3ERR collects the arguments from a calling FORTRAN program and passes them to X3ERRA which does the actual work. First, the processor ID is added into the first two bits of the error code word (1=MSC, 2=NAV, 3=RCV). Next, X3ERRA checks to see if there is enough room in the error buffer to insert the error message. If not, it reports an error dropped. It then stuffs the error message into

the buffer and returns control to the calling task.

Note: Error messages can be up to 11 words long. If an error message is passed to X3ERR that exceeds this limit, an error so noting is logged. If one is passed directly to X3ERRA, the message is truncated to 11 words.

5.4.9 X3REL

Mnemonic: X3REL

Title: Relinquish sole access

Priority: None (Excutive service routine)

Invoked by: M1DBPR, M2DBS1, M2DBS2, M2DBS3, M2STIN, N1MCNS, N2SVEC, N2SVSL

Invokes: X3ERRA

Inputs: From data sets XIMSK, XWORK; from argument list SEMA4

Parameter	Source
X3REL workspace (XWORK)	XWORK
Mask to disable 5 ms interrupt (XIMSKP)	XIMSK
Mask to restore 20 ms interrupt (XIMSK7)	XIMSK
Address of exclusive access semaphore (SEMA4)	Calling subprogram

Outputs:

Parameter	Destination
Address of exclusive access semaphore (SEMA4)	Calling subprogram

Processing:

X3REL releases exclusive access to the data set passed as an argument. The address of the exclusive access semaphore is passed through the workspace in register 14. The semaphore is set to -1 and the 20 ms interrupt is re-enabled. An error is logged if the number of arguments passed to X3REL is not one.

AD-A076 484 TEXAS INSTRUMENTS INC DALLAS EQUIPMENT GROUP F/G 17/7
GLOBAL POSITIONING SYSTEM (GPS). MANPACK/VEHICULAR USER EQUIPME--ETC(U)
AUG 79 F04701-75-C-0181
UNCLASSIFIED SAMSO-SD-TR-79-13-VOL-3 NL

3 OF 5
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5.4.10 X3REQ

Mnemonic: X3REQ

Title: Request sole access utility

Priority: None (executive service routine)

Invoked by: M1DBPR, M2DBS1, M2DBS2, M2DBS3, M2STIN, N1MCNS, N2SVEC, N2SVSL

Invokes: X3ERRA

Inputs: From data sets XIMSK, XWORK; from argument list SEMA4

Parameter	Source
X3REQ workspace (XWORK)	XWORK
Mask to disable 20 ms interrupt	XIMSK
in X3REQ (XIMSKP)	XIMSK
Mask to disable 20 ms interrupt in calling task (XIMSKS)	XIMSK
Exclusive access semaphore (SEMA4)	Calling task

Outputs:

Parameter	Destination
Exclusive access semaphore (SEMA4)	Calling task

Processing:

X3REQ is designed to grant to the calling program exclusive access to a specified data set. A semaphore associated with the data set is set to 1 when access is granted. The 20 ms interrupt is disabled to ensure exclusivity. An error is logged if access cannot be granted within 1 millisecond of the request. Also, if the number of arguments passed to X3REQ is not one, an error is logged.

5.4.11 X3STOP

Mnemonic: X3STOP

Title: Process stop server

Priority: None (executive service routine)

Invoked by: N1INIT, Receiver subsystem

Invokes: X1DISP

Inputs: From data sets XOPRC, XOLEV, XIMSK

Parameter	Source
Number of FTF's since start of process (OLEVFA)	XOLEV
Pointer to next process in priority (OPRCNP)	XOPRC
Pointer to previous process in priority (OPRCPP)	XOPRC
Non-error interrupt mask (XIMSKE)	XIMSK

Outputs:

Parameter	Destination
Workspace pointer of preempted process (OPCRWP)	XOPRC
Program counter of preempted process (OPRCPC)	XOPRC
Status register of preempted process (OPRCST)	XOPRC
FTF count at process end (OPRCEC)	XOPRC
Pointer to process now running (OLEVPN)	XOLEV
Pointer to next process in priority (OPRCNP)	XOPRC
Pointer to previous process in priority (OPRCPP)	XOPRC

Processing:

X3STOP is designed to deactivate the calling task while requesting the dispatcher to execute the next process in the priority. The workspace pointer, program counter and status register of the calling task are saved in the process block along with the current FTF count. The pointer to the next process to be run is set to point to the next process. The calling process is removed from the

process chain, and finally the dispatcher is called to transfer control to the next process.

5.4.12 X3STOR

Mnemonic: X3STOR

Title: Stopping service for 1 ms task

Priority: None (executive service routine)

Invoked by: R1AID, R1BSN, R1MRC, R1PCK, R1RNG, R1RRM

Invokes: None

Inputs: From data set XACRU

Parameter	Source
CRU address to clear interrupts (XACRUC)	XACRU
CRU address to enable/disable interrupts (XACRUE)	XACRU

Outputs: To data sets XOPRC, XOLEV, XINT

Parameter	Destination
Process workspace pointer (OPRCWP)	XOPRC
Process program counter (OPRCPC)	XOPRC
Bit map of enabled interrupts (XIENAB)	XINT
Pointer to previous process in priority (OPRCPP)	XOPRC
Pointer to first process in priority (OLEVPF)	XOLEV

Processing:

X3STOR deactivates the receiver's 1 ms interrupt task and returns control to the task interrupted. The 1 ms interrupt is cleared, disabled, and removed from the bit map of active interrupts. Also, the process chain is cleared since there is only the one task in it.

5.4.13 X3TIME

Mnemonic: X3TIME

Title: 20 ms count fetcher

Priority: None (executive service routine)

Invoked by: M1CMSC

Invokes: X3ERRA

Inputs: None

Outputs: From data set XCOUNT

Parameter	Destination
20 ms count, word 1 (XC0020)	R0 of calling task
20 ms count, word 2 (XC0022)	R1 of calling task

Processing:

X3TIME transfers the current time, expressed in 20 ms units, to registers zero and one of the calling task.

5.4.14 X3TIMM

Mnemonic: X3TIMM

Title: Modulo(X) 20 ms time fetcher

Priority: None (executive service routines)

Invoked by: X1IT20, M1ADIS, M1CCIO, M1CMSC, M1DBPR, N1CMNS
N1MITK, N1NFLT, N1SVPN, N1XFRM, N2MCNI
N2SVSL

Invokes: X3ERRA

Inputs: From data set XCOUNT; from argument list MOD

Parameter	Source
20 ms count - word 1 (XC0020)	XCOUNT
20 ms count - word 2 (XC0022)	XCOUNT
Modulus for returned value (MOD)	Calling task

Outputs: To calling task

Parameter	Destination
Modulo time	R0 of calling task

Processing:

X3TIMM returns the 20 ms count in the modulo of the passed parameter. The result is placed into the task's R0. An error is logged if more than one argument is passed or if the argument is negative.

5.4.15 X3WAIR

Mnemonic: X3WAIR

Title: Wait service for the 1 ms epoch task

Priority: None (executive service routine)

Invoked by: R1AID, R1BSN, R1MRC, R1PCK, R1RNG, R1RRM

Invokes: None

Inputs: None

Outputs: From data set XOPRC

Parameter	Destination
Process workspace pointer (OPRCWP)	XOPRC
Process program counter (OPRCPC)	XOPRC

Processing:

X3WAIR stores away the workspace pointer and program counter of the 1 ms interrupt handler to indicate the place to return to when the next interrupt occurs. Control is returned to the interrupted task upon completion of X3WAIR.

5.4.16 X3WAIT

Mnemonic: X3WAIT

Title: Process wait service

Priority: None (executive service routine)

Invoked by: X1RPRT, X1COMM, X1COMN, X1RPRT, M1ADIS, M1CCIO, M1CMSC, M1CRNC, M1DBPR, M1IIUO, M1PDBR, N1INIT, N1MCNS, N1MITK, N1NFLT, N1SVPN, N1XFRM, B1SLIO, R1AID, R1CAL, R1CC, R1DDT, R1FMT, R1MRC, R1MTM, R1NSE, R1PCK, R1PIN, R1RNG, R1RRM, R1SCH, R1SET, R1SRC

Invokes: X1DISP

Inputs: From data set XOLEV

Parameter	Source
Number of FTF's since period readied (OLEVFA)	XOLEV

Outputs: To data set XOPRC

Parameter	Destination
Process workspace pointer (OPRCWP)	XOPRC
Process program counter (OPRCPC)	XOPRC
Process status register (OPRCST)	XOPRC

Processing:

X3WAIT saves the calling task's WP, PC, and ST, selects the next process in the priority, and summons the dispatcher to grant control to the next process.

5.4.17 X9MPMB

Mnemonic: X9MPMB

Title: Allocation of global data sets on MPM board

Priority: None

Invoked by: None

Invokes: None

Inputs: None

Outputs: None

Processing:

X9MPMB allocates the 240-word RAM residing on the MPM board in each of the three processors. The following data sets are included:

XWORK -- Common workspaces used by executive programs

XCOUNT -- Interrupt counters; includes 20-ms and 1-ms counts along with 20-ms mod(16), 5-ms mod(4), and 10-ms mod(2).

XINT -- Interrupt status table; bit map of enabled interrupts, processor interrupt mask.

XERROR -- Error recording buffer; used by X3ERRA to log program errors

XPSTER -- Processor self-test buffer; contains information on four possible processor self-test errors.

XACRU -- CRU addresses; CRU bases to clear and disable/enable interrupts.

XIMSK -- Interrupt masks used by the executive.

5.4.18 X9MVUE

Mnemonic: X9MVUE

Title: Allocation of global data sets for MVUE processor

Priority: None

Invoked by: None

Invokes: None

Inputs: None

Outputs: None

Processing:

X9MVUE allocates all global data sets residing on the local PMM's and DMM's as follows:

XGROUP -- Scheduling categories; contains number of priorities per category (1-ms, 5-ms, 20-ms and background) and pointer to highest priority.

XSTART -- Power-on table; includes interrupts to be enabled, number of priorities, number of processes, number of tasks to activate, and which ones to activate.

XACRMV -- MVUE CRU addresses; contains values for test latch, CDU read/write, timer, and memory paging.

XDATA -- Length of utility storage space and offset

XNUMBR -- Lengths of tables and subblocks

XHOME -- Subsystem identity; contains data elements identifying set as MVUE subsystem.

XARR -- Allocation of ROM and RAM; contains ROM and RAM boundaries along with ROM checksums.

XZ -- Pointers to commands and reports; contains pointers to 20-ms update command, memory read/write command, memory contents report, error report, and first update command received.

XTASK -- Task definition table; contains the following for each task:

word 1) Pointer to information block
word 2) Priority level pointer
word 3) Process pointer
word 4) Max number of concurrent tasks
word 5) Task entry point

XFTF -- Fundamental time frame table; contains for each priority a block formed as following:

word 1) FTF unit from which priority is formed
word 2) Priority period in FTF's
word 3) Pointer to variable storage space for utilities in the priority
word 4) Pointer to workspace for FPAU use

XPROC -- Process status table; contains the following information for

each process:

word 1) Pointer to next process in priority
word 2) Pointer to preceding process in priority
word 3) Workspace pointer (WP)
word 4) Program counter (PC)
word 5) Status register (ST)
word 6) FTF count when last given control
word 7) Ending FTF count

XLEVEL -- Priority level table; contains following information for each priority;

word 1) Pointer to process now running
word 2) Pointer to first process in priority
word 3) 0
word 4) FTF unit from which priority was formed
word 5) Period in FTF's
word 6) Number of FTF's since period was readied
word 7) Number of FTF's priority took to run last period
word 8) Pointer to variable storage space for utilities in priority
word 9) Number of utilities called - number of utilities returned
word 10) Pointer to workspace for FPAU use
word 11) Flag indicating if the priority is using the FPAU

XUTIL -- Allocation of variable storage space for reentrant utilities

XXWORK -- Workspaces for Floating Point Server in each priority

5.4.19 X9TRAP

Mnemonic: X9TRAP

Title: Allocation and initialization of interrupt transfer vectors

Priority: None

Invoked by: None

Invokes: None

Inputs: None

Outputs: None

Processing:

X9TRAP allocates the interrupt transfer vectors (WP, PC) for the seven levels of interrupts in the processors as follows:

Level 1 -- Memory parity error

Level 2 -- Unwanted

Level 3 -- I-bus time-out

Level 4 -- FPAU increment or 1-ms epoch

Level 5 -- FPAU status or 5-ms time mark

Level 6 -- 20-ms time mark

Level 7 -- Unwanted

6.0 HARDWARE MODULES

6.1 RECEIVER SECTION

6.1.1 RF PRE-CONDITIONNG MODULES

6.1.1.1 GENERAL DESCRIPTION

The primary function of the RF Pre-Conditioning Modules is to increase the power level and to provide some filtering of the inputted RF signals prior to routing to the rest of the system. A limiting capability is also incorporated to prevent the rest of the system from getting damaged in the case of an abnormally large signal level.

6.1.1.2 FUNCTIONAL DESCRIPTION

As shown in Figure 6.1.1-1 the RF Pre-conditioning Modules consist of three modules. The modules include the Diplexer/Filter, Limiter, and the Pre-amplifier. The Diplexer/Filter accepts two inputs. These inputs are the system L1 and L2 (154fo and 120fo respectively). The L1 and L2 signals are filtered individually in a filter of 40 MHz bandwidth maximum and then they are combined internal to the diplexer and outputed to the Limiter. The Limiter functions to limit the signal the Pre-amplifier receives when the signal exceeds a power level of Odbm (nominal).

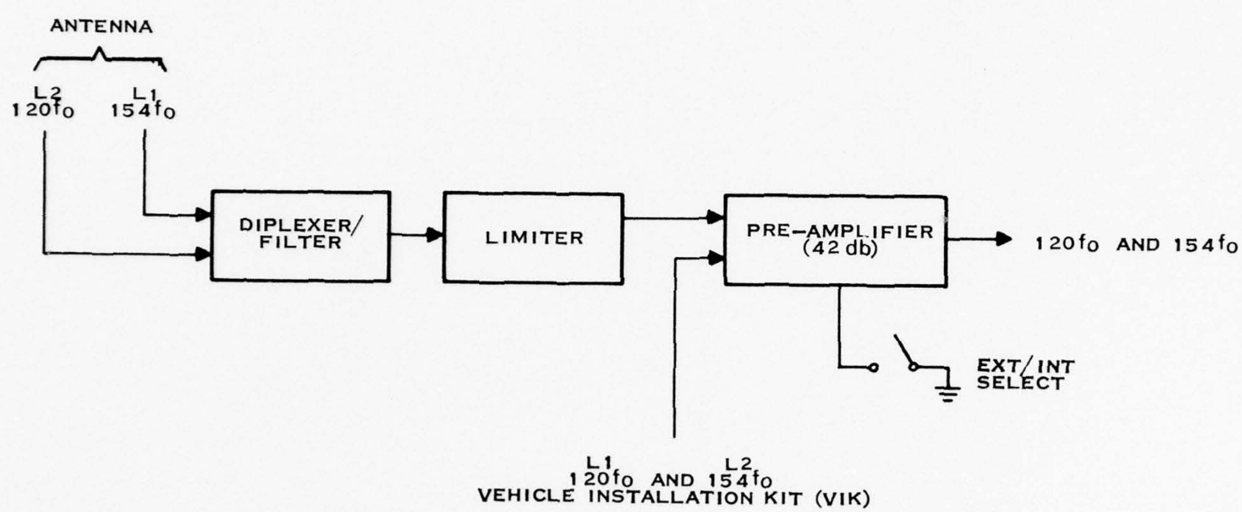

Figure 6.1.1-1. RF Pre-Conditioning Modules

The Pre-amplifier strictly amplifies the signal by 42 db (nominal) and forwards the signal to the next portion of the system. The Pre-amplifier also accepts another set of L1 and L2 signals from another source which are not amplified. The Pre-amplifier is equiped with an internal RF switch which allows selection of either the amplified RF carrier or RF carrier from another source to be outputed to the next system portion.

6.1.1.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
RF	Ant L1 and L2	1542.75 MHz(L1) and 1227.6 MHz(L2 at a power level of -133 dbm (nominal). Contains all SV information (C/A code, p-code and Data.)	System Antenna
RF	VIK L1	1542.75 and 1227.6 MHz at a power level of -95dbm (nominal).	Vehicle Installation Kit
Logic	EXT/INT select	TTL signal which allows selection of one of the two RF sources.	System

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTINATION
RF	154Fo and 120Fo	1542.75 and 1227.6 MHz RF carrier at a power level of -95 dbm (nominal).	WBD

6.1.2 WIDEBAND MODULE

6.1.2.1 GENERAL DESCRIPTION

The primary functions performed by the Wideband Module (WBM) are those of RF signal amplifying, mixing, pre-filtering, and automatic gain control. The incoming RF is mixed down to IF for output to the NBM's. A pre-filtering function allows the processor to select between an L1 or L2 path within the WBM which limits interference from sources outside the stopband. The module is equipped with automatic gain control which is responsive to both signal power and noise power.

6.1.2.2 FUNCTIONAL DESCRIPTION (refer to Figure 6.1.2-1)

As shown in Figure 6.1.2-1 the WBM is a series of mixers, amplifiers and filters which process the incoming signal. The module accepts L1 and L2 (154 Fo and 120 Fo respectively) from an external source. The signal is routed to an amplifier of 15 dB gain. The input amplifier forwards its signal to two filters, one of which is for L1 and the other for L2. Each filter has a bandpass of approximately 25 MHz. The output of each filter is fed to a SPDT RF switch which allows the processor to select either an L1 or L2 path.

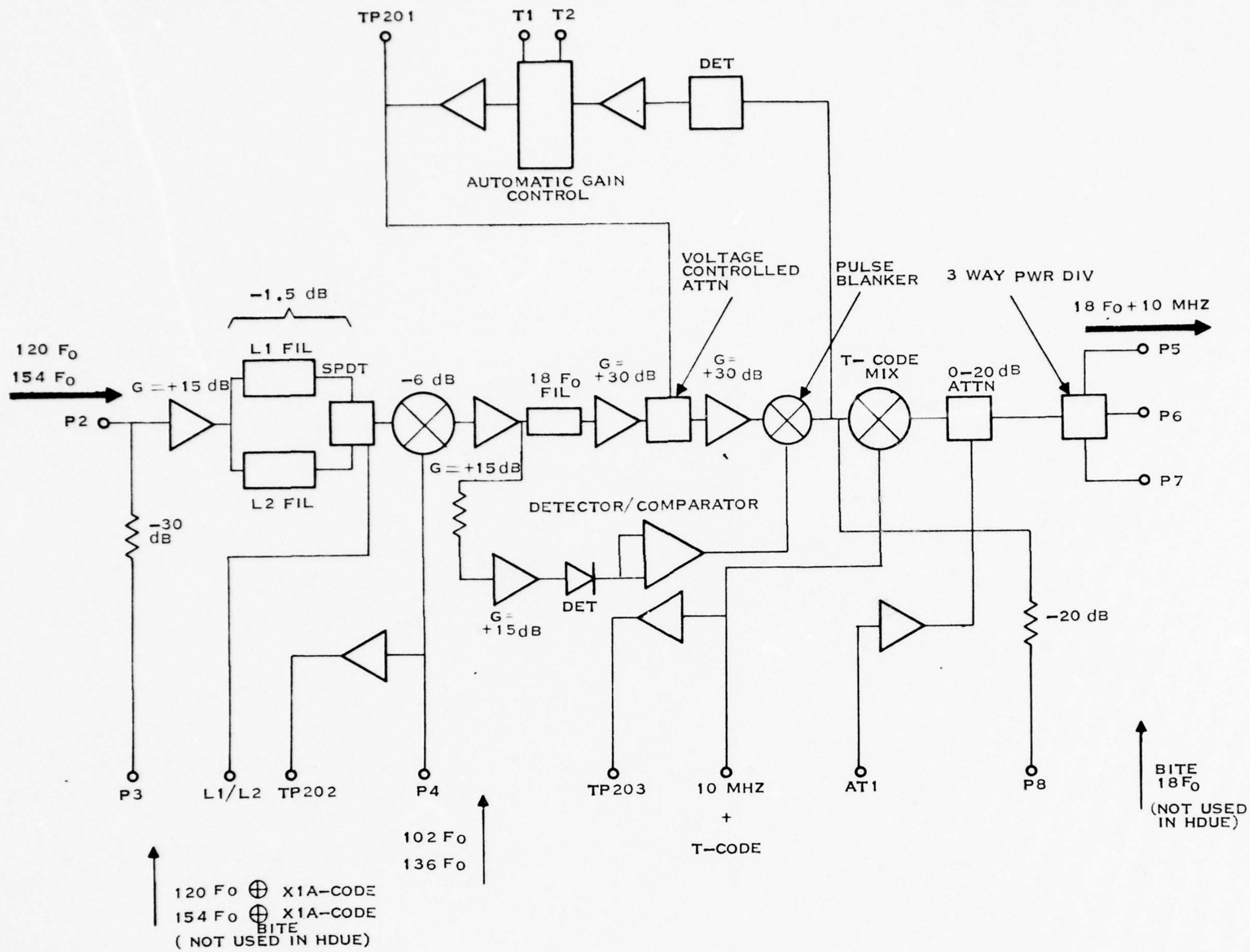

Figure 6.1.2-1. Functional Block Diagram Wideband Module

The RF switch output is forwarded to the first down-conversion mixer which accepts L.O. input of either 136 Fo or 102 Fo. This L.O. frequency is determined by the desired mode of operation (L1 or L2) and is controlled external to the module. The mixer produces an IF signal of 18-Fo which is routed to a second 15 dB gain amplifier. The output of this amplifier is fed into an 18-Fo Surface Wave Filter (SWF) which has a bandwith of 15 MHz. The output from the SWF is forwarded to a 30-dB gain amplifier prior to input to a Voltage Controlled Attenuator. This attenuator may be varied between 1.5 and 40 dB as a function of its input control voltage (AGC Signal). The output of the attenuator is inputted to another 30-dB gain amplifier which feeds a Pulse Blanker mixer. This mixer performs the function of attenuating the 18-Fo signal if it exceeds a high power threshold as detected at a point prior to the SWF by the Detector/Comparator section.

The output of the Pulse Blanker mixer is forwarded to the Automatic Gain Control (AGC) section and a T-code mixer. In the AGC section the output of the blanker mixer is detected and is routed through a time constant control circuit which allows the system processor to invoke either a 2-second or a 1-msec time constant on the detected signal. The AGC signal is then forwarded to the Voltage Controlled Attenuator. The T-Code Mixer mixes the 18-Fo IF with a 10-MHz signal which has been mixed with T Code. T Code is a pseudo-random code created by sampling the replica P Code in

the system at a 10-KHz rate.

The output of the T-Code Mixer is an 18-Fo + 10-MHz IF signal which is routed to a processor-controlled 20-dB attenuator. The attenuation options are either 0 dB or 20 dB, with the 20-dB option utilized with the BITE signal which is normally 20 dB above the nominal SV signal at this point in the system. The output of the attenuator is forwarded to a 3-Way Power Splitter which provides 18 Fo + 10 MHz to the NBM's.

6.1.2.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE
RF	SV signal	L1 and L2 carriers modulated with P Code, C/A Code, and data (-95 dBm nominal)	external preamp
RF	L1,L2 BITE	Built-in test signal (-50 dBm)	BITM not used in HDUE
RF	BITE 18 Fo	Built-in test signal (-30 dBm)	BITM not used in HDUE
RF	LO1	136 Fo or 102 Fo (¦7 dBm)	FSM
RF	10MHz T-code	mixer signal	FSM
PWR	5.2 VDC	40 ma	pwr sup
PWR	5.0 VDC	70 ma	pwr sup
PWR	-5.0 VDC	10 ma	pwr sup
PWR	12.0 VDC	100 ma	pwr sup
PWR	-12.0 VDC	60 ma	pwr sup
Logic	CLL1L2	TTL (to select either the L1 or L2)	OM
Logic	CLATT	TTL (to invoke 20-dB attenuator)	OM
Logic	CLTAU1	TTL (to select the 2-sec time constant for AGC)	OM
Logic	CLTAU2	TTL (to select the 1-msec time constant for AGC)	OM

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTIN.
RF	VHF Signal	18 Fo, 10 MHz, P (or C/A) code, data, + T Code (-62 to -25 dBm))	NBM's

6.1.3 NARROWBAND MODULE

6.1.3.1 GENERAL DESCRIPTION

The Narrow-Band Module (NBM) contains the code correlation circuitry followed by a down converter to baseband to obtain the loop tracking error signals data demodulation.

6.1.3.2 FUNCTIONAL DESCRIPTION (refer to Figure 6.1.3-1)

I. Code correlation and down conversion

The NBM module receives a signal of 18Fo + 10 MHz (Fo is nominally 10.23 MHz) modulated with P code (and/or C/A code), SV data, and T code from the WBM. The 10 MHz is used to offset the IF from harmonics of Fo and the T code is used to aid in CW jamming immunity. The signal is mixed in the correlator with the replica P and T codes (or replica C/A and T codes), amplified, then fed through a narrow band surface wave filter to give the carrier (18 Fo + 10 MHz) with data. This signal is mixed with 17 Fo and fed through a crystal filter to give Fo + 10 MHz with data. The signal is then fed through an AGC controlled amplifier, split and fed to two seperate channels: 1) an error channel and 2) a data channel.

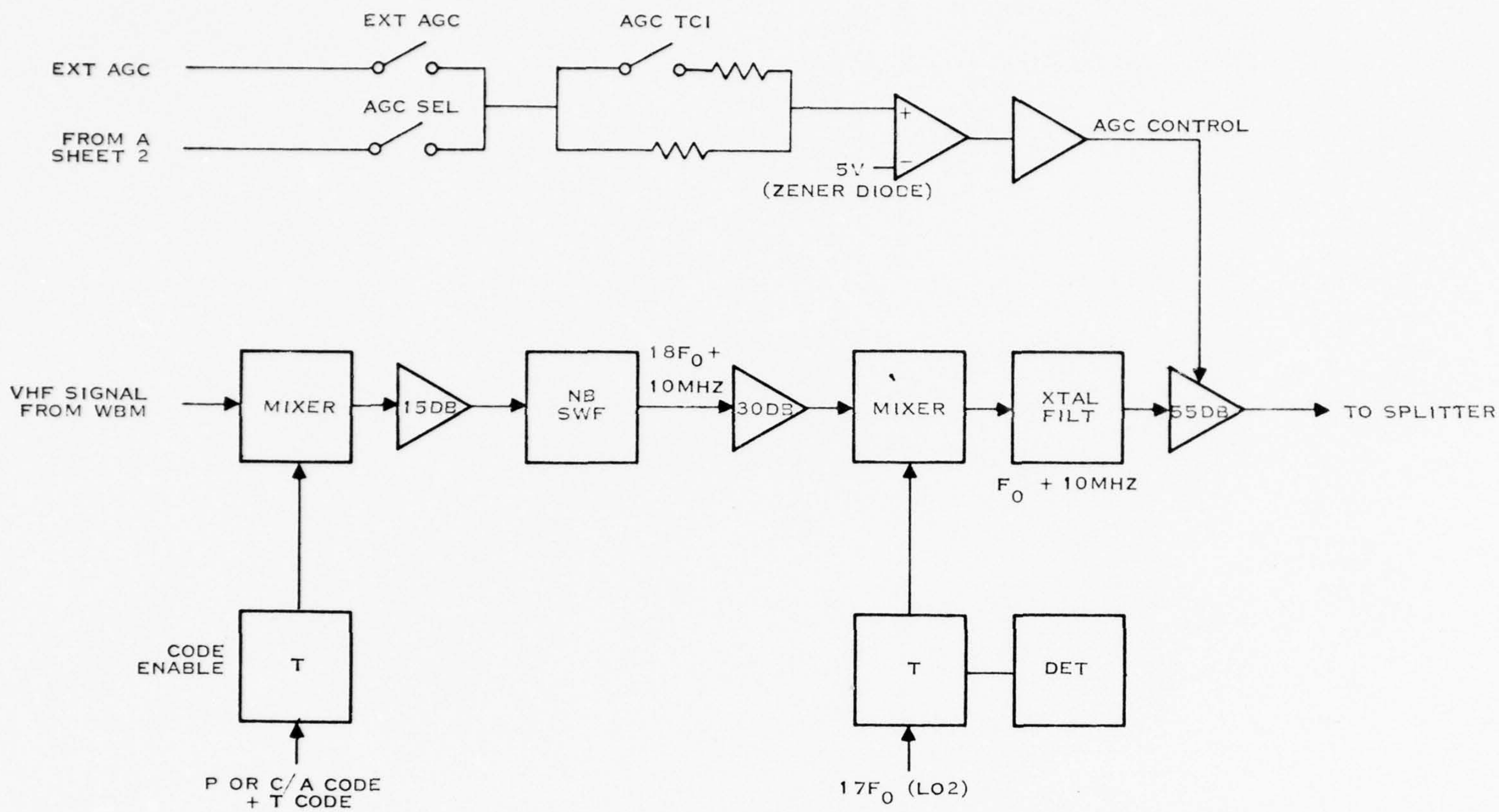

Figure 6.1.3-1. Functional Block Diagram of the NBM (Sheet 1)

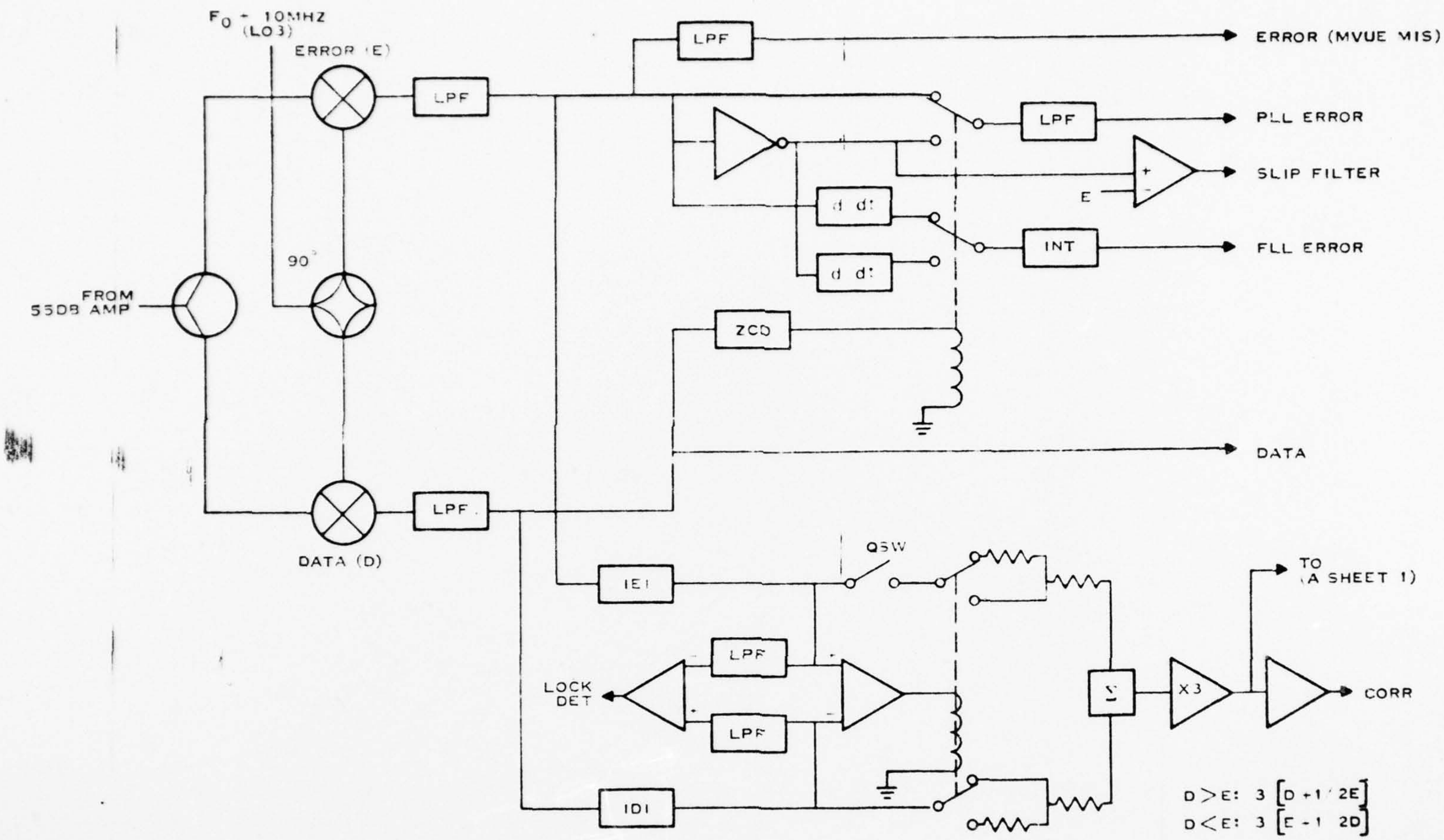

Figure 6.1.3-1. Functional Block Diagram of the NBM (Sheet 2)

Fo + 10 MHz from the frequency synthesizer module is fed through a quadratrure hybrid to mixers in both of these channels, with the data channel having a 90 degree phase shift with respect to the error channel. The signals from both mixers are fed through Low Pass Filters (LPF) leaving only data and error signals. Data is removed from the error signal by selecting an inverted or noninverted signal with a zero crossing detector fed from the data signal. The filtered output is the Phase Lock Loop (PLL) error voltage.

The above method is used to remove data from differentiated error signals. The resultant signal is passed through an integrating circuit for the Frequency Lock Loop (FLL) error voltage.

II. Determination of existance and quality of code lock

Both error and data signals are passed through absolute value detectors and compared. When the absolute value of the data signal is 0.3V greater than that of the error, lock is declared on the DOLOCK output.

The degree of correlation is determined by feeding the Error (E) and Data (D) signals through a circuit that is an approximation of an envelope detector. The absolute values of the E and D signals are fed through a switch, a resistor divider network and a summing

circuit to an amplifier set up for a gain of 3X. The switch is controlled by a comparator monitoring the absolute values causing an output of 3(|D| + 1/2 |E|) for |D| > |E| or 3(|E| + 1/2 |D|) for |E| > |D|. This value (correlation voltage) is sent externally to the output module and internally to an amplifier referenced to 5 VDC to develope AGC.

Because most of the useful information is in the data channel when the receiver is in solid phase lock, a Q-switch was implemented to remove the error channel input to the correlation voltage signal to noise ratio, but subsequently discarded because of the inherent complexity under marginal phase lock conditions.

To enable the processor to perform a quality check of the carrier track precision the error signal is applied to a comparator whose output (HISLIP) goes to the output module for an ultimate cycle slip rate accumulation in the processor.

6.1.3.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE
RF	VHF Signal	18 Fo, 10 MHz, P (or C/A) code, data, + T code (-62 to -25 dBm)	WBM
RF	LO2	173.91 MHz nominal (9dBm)	FSM
RF	LO3	Fo and 10 MHz (9dBm)	FSM
Power	5 VDC RF	25 ma	pwr sup
Power	-12 VDC	26 ma	pwr sup
Power	12 VDC	36 ma	pwr sup
Power	5V logic	35 ma	pwr sup
Analog	EXT AGC	External AGC (not used)	OM
Code	Code	TTL (P (or C/A) code and T code)	CGM
Logic	CLAGCTC	TTL (AGC time constant control bit)	OM
Logic	CLAGSEL1	TTL (internal/ external AGC control bit)	OM
Logic	CLQSW	TTL (Q switch control bit)	OM
Logic	Code Enable	TTL (replica correlation code enable bit)	BITM

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTINATION
Analog	EPLL	Phase Lock Loop Error voltage	FSM
Analog	EFLL	Frequency Lock Loop Error voltage	FSM
Analog	CHxCOR	Correlation voltage	OM
Analog	Data	Data signal	OM
Logic	HISLIPA	TTL (slip detection bit)	OM
Logic	LOSLIPA	not connected in module	OM
Logic	DOLOCK	TTL (lock detection bit)	OM

6.1.4 FREQUENCY SYNTHESIZER MODULE

6.1.4.1 GENERAL DESCRIPTION

The Frequency Synthesizer Module (FSM) comprises the circuitry necessary to provide local oscillator signals to various mixers in the GPS receiver. These local oscillator signals are phase locked to the received signals.

6.1.4.2 FUNCTIONAL DESCRIPTION (refer to Figure 6.1.4-1)

I. Voltage Controlled Oscillator (VCO) and it's internal control loop.

The VCO is a push-pull oscillator with a tank circuit, whose frequency is controlled both by the voltage applied and by the L1/L2 digital input from the digital control circuitry. The L1/L2 digital input causes a section of the tank circuit to be bypassed in L1 to produce 136 Fo. In L2 the full tank circuit is in for an output of 102 Fo. One half of the output frequency (68 Fo or 51 Fo) is tapped off of one side of the push-pull oscillator and fed through a divide-by-4 (or 3) circuit to produce 17 Fo. For L1 its a divide-by-4 and L2 a divide-by-3.

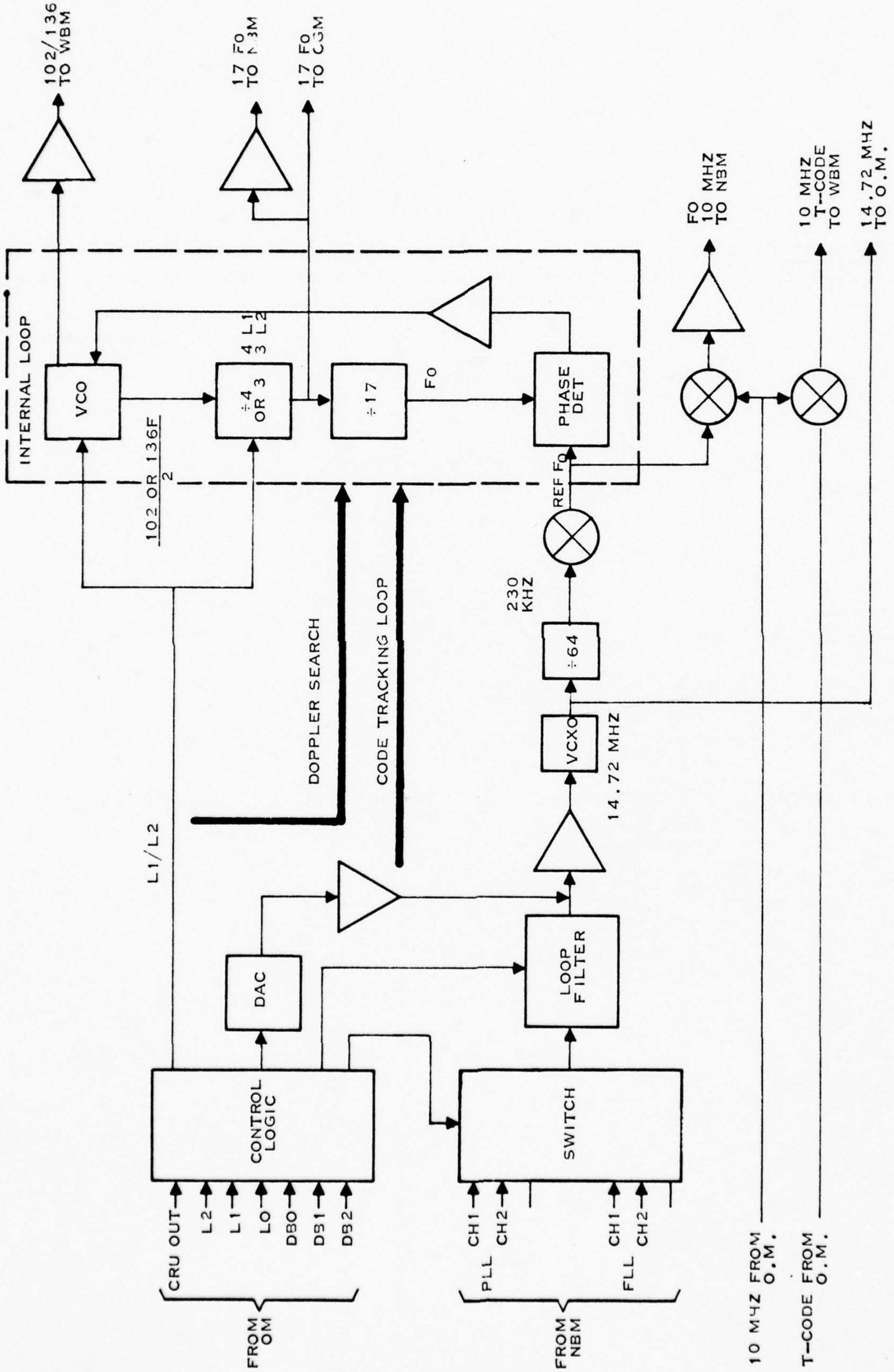

Figure 6.1.4-1. Functional Block Diagram Frequency Synthesizer Module

The output of this divider (17 Fo) is fed through a divide-by-17 circuit to a phase detector. The phase detector is referenced to a Fo with a frequency controlled by the SV signal to allow for doppler shift and for reference oscillator drift, or by a logic-generated calibration/search signal. The voltage developed by the detector in comparing the phase difference is fed through an active filter to control the VCO frequency.

The outputs of the internal loop are the 102/136 Fo and the 17 Fo. The 102/136 Fo (the first L.O.) is sent to the wide band module to be mixed with the RF. The 17 Fo (the second L.O.) is sent to the narrow band module to be mixed with the IF for the second conversion and to the code generator module to be mixed with the P or C/A code.

II. Frequency synthesizer portions of the carrier tracking loop.

The Phase Lock Loop (PLL), Frequency Lock Loop (FLL) Narrowband Module NBM channel 1 or 2 error voltage inputs are applied to a switch, the positioning of which is determined by the control logic. The error selected is applied to a loop filter with a response determined by the control logic. The output of the loop filter controls the frequency of the Voltage Controlled Crystal Oscillator (VCXO).

The output of the VCXO (nominally 14.72 MHz) is divided by 64 giving a nominal 230 KHz. This mixed with 10 MHz from the Signal Distribution Module (SDM) (developed by the reference oscillator) produces the reference Fo (nominally 10.23 MHz) for the afore mentioned internal loop.

The external outputs of the section just described are 14.72 MHz and Fo. The 14.72 MHz is sent to the output module. Fo is mixed with the 10 MHz and sent to the last mixer stage in the NBM's

III. Doppler search

Doppler search is accomplished by altering the logic inputs to the control logic, in turn altering the digital input to the Digital-to-Analog Converter (DAC). The output of the DAC, representing the digital input, is fed through two amplifiers to the VCXO in order to control the frequency. The frequency is systematically altered to cover all practical doppler frequencies until lock is established and the carrier tracking loop takes control.

6.1.4.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE
RF	10 MHz	TTL (reference signal)	SDM
Power	12 VDC	10 ma	pwr sup.
Power	-15 VDC	55 ma	pwr sup.
Power	-5 VDC	6 ma	pwr sup.
Power	5.2 V RF	570 ma	pwr sup.
Power	5 V Logic	102 ma	pwr sup.
Power	12 VDC Standby	40 ma (nominal)	pwr sup.
Logic	CPDB0	TTL (decode address line)	OM
Logic	CPDB1	TTL (decode address line)	OM
Logic	CPDB2	TTL (decode address line)	OM
Logic	CPDACLOAD	TTL (DAC load pulse)	CM
Logic	500CRUOUT	TTL (CRU data)	OM
Logic	500L0	TTL (L field decode bit)	OM
Logic	500L1	TTL (L field decode bit)	OM
Logic	500L2	TTL (L field decode bit)	OM
Code	T code	TTL (5 KHz code for CW jamming immunity aid)	CGM
Analog	EPLL A	Phase Lock Loop Error voltage	NBM A
Analog	EPLL B	Phase Lock Loop Error voltage	NBM B
Analog	EFLL A	Freq. Lock Loop Error voltage	NBM A
Analog	EFLL B	Freq. Lock Loop Error voltage	NBM B

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTIN.
RF	10 MHz + T code	TTL	WBM
RF	14.72 MHz	TTL	OM
RF	LO2	2nd local oscillator--17 Fo (6 dBm)	NBM A
RF	LO2	2nd local oscillator--17 Fo (6 dBm)	NBM B
RF	LO3	3rd local oscillator--Fo + 10 MHz (9 dBm)	NBM A
RF	LO3	3rd local oscillator--Fo + 10 MHz (9 dBm)	NBM B
RF	LO1	1st local oscillator-- 102/136 Fo (7 dBm)	WBM
RF	17Fo	6 dBm	

6.1.5 OUTPUT MODULE

6.1.5.1 GENERAL DESCRIPTION

The receiver Output Module (OM) contains the circuitry that modifies the signals between the processor and the receiver RF modules, allowing transfer of information in both directions.

6.1.5.2 FUNCTIONAL DESCRIPTION (refer to Figures 6.1.5-1 and 6.1.5-2)

The OM circuitry may be divided into four main signal processing functions. These functions are: (1) processor control interface (2) range rate count, (3) data conversion, and (4) correlation voltage conversion.

I. Processor control interface

The OM deciphers information sent from the processor through the CRIM and sends the results as control signals to respective receiver modules.

RXSEL determines the receiver channel, M, B and L fields determines the address, CRUOUT contains the data, and CRUCLK contains the processing clock.

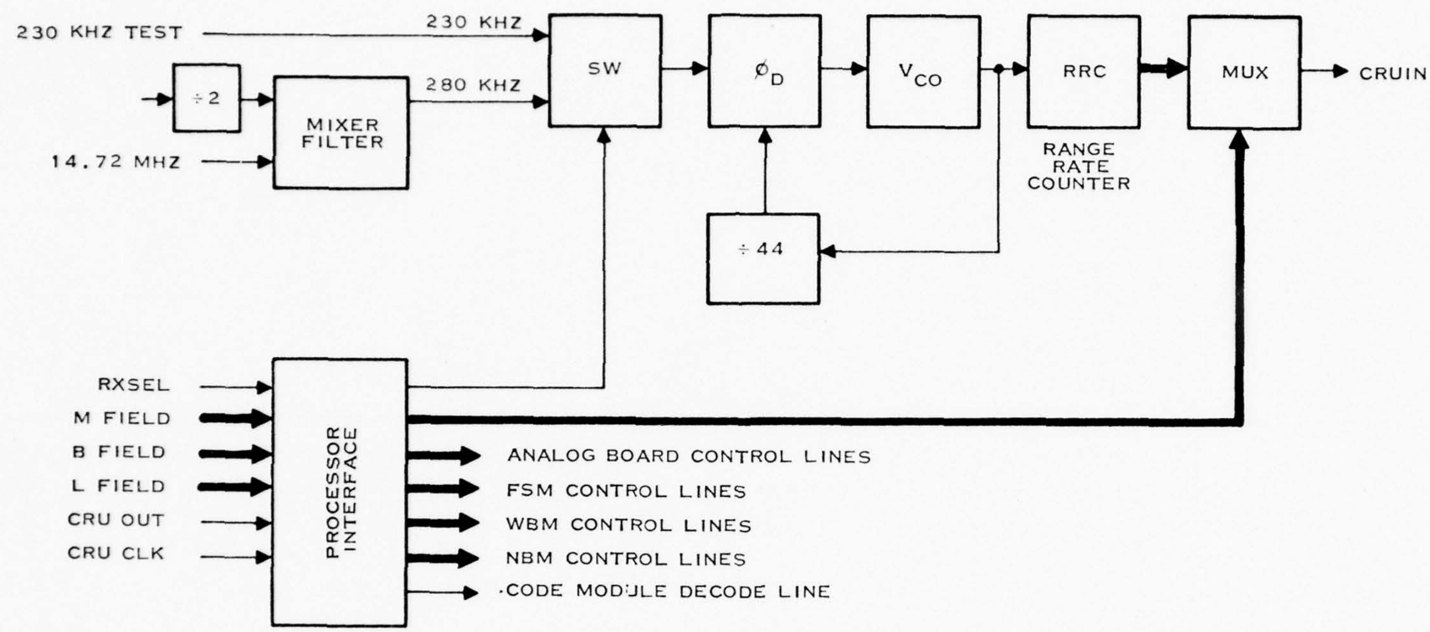

Figure 6.1.5-1. Functional Block Diagram Output Module Digital Board

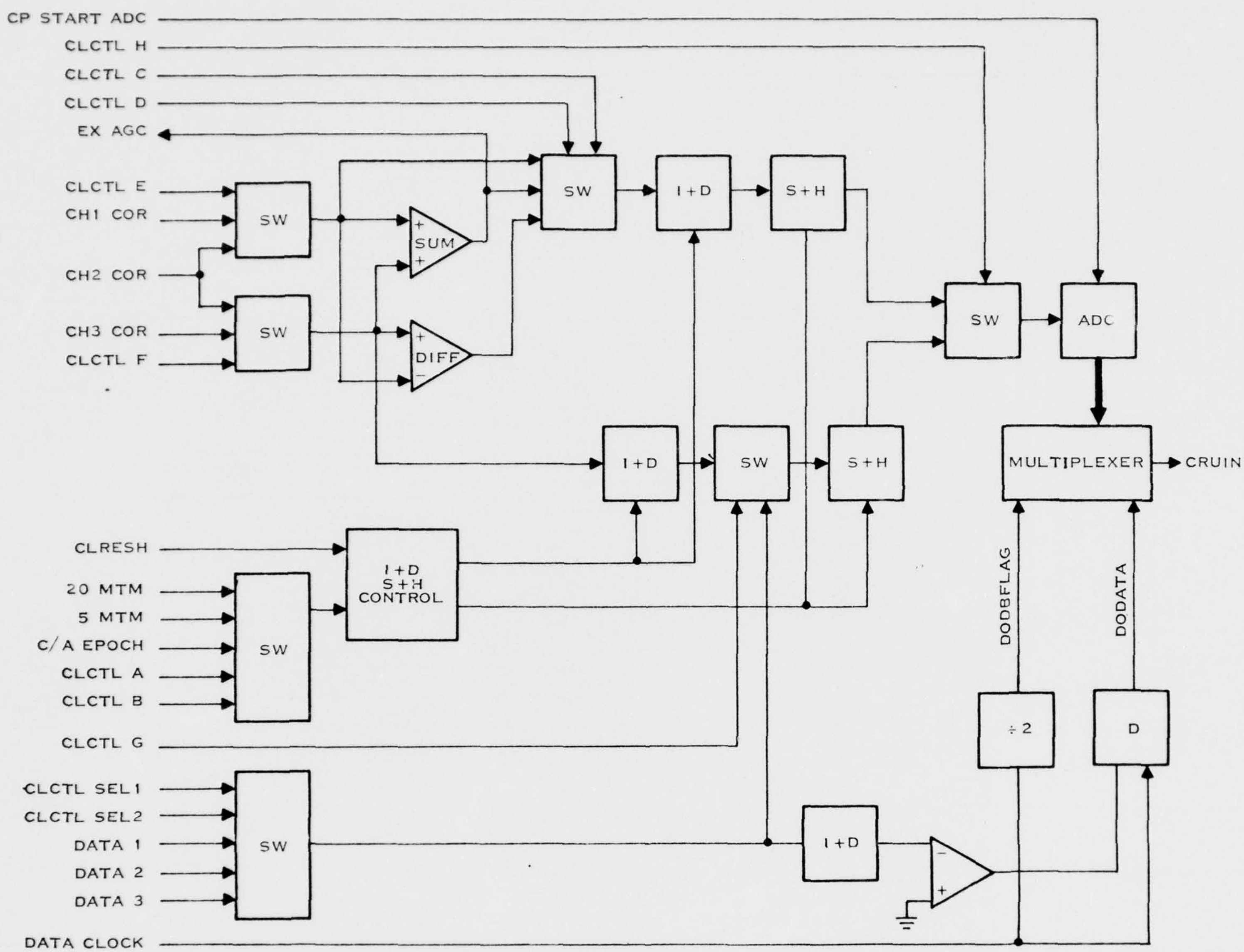

Figure 6.1.5-2. Functional Block Diagram, Output Module, Analog Board

II. Range Rate Count (RRC)

The RRC contains a mixer, phase lock loop, and counter. 10 MHz from the reference oscillator is divided by 2 and fed to a mixer along with 14.72 MHz from the frequency synthesizer module. This 14.72 MHz has a frequency shift on it caused by doppler and clock bias. A low pass filter selects the difference between the second harmonic of 5 MHz and the 14.72 MHz to give a nominal 280 KHz. This 280 KHz is fed through a switch to the signal input of a phase detector.

The VCO output (a nominal 12.32 MHz) is fed through a divide-by-44 circuit to the compare input of the phase detector. The phase detector output controls the frequency of the VCO.

The VCO output is fed to a series of ripple through counters which are enabled and preset at predetermined intervals. The output of these counters is applied to a series of decoders whose outputs, representative of the range rate, go to CRUIN.

For a counter test, 230 KHz from the built in test module is switched into the input of the phase detector, thus controlling the VCO at a nominal 10.12 MHz.

III. Data conversion

Data enters the OM from the NBM'S and progresses through a switch to an Integrate-and-Dump (I+D)

circuit, which is controlled by the Data Clock. The I+D output is applied to a comparator which converts the signal to a TTL level and applies it to the D input of a flip-flop. This data is clocked through the flip-flop with the same DATA CLOCK to a multiplexer, which sends this data to CRUIN when selected.

For a histogram of the data the analog signal is also passed through a switch to a Sample and Hold (S+H) circuit. Then it is fed through another switch to an Analog-to-Digital Converter (ADC). The resulting digital output, representing a histogram of the SV data, is fed to the multiplexer where it is sent out on CRUIN.

IV. Correlation Voltage Conversion

The correlation voltages from the NBM'S are fed through switches to the input of a sum circuit, difference circuit, and a switch. The processor selects one of these signals and applies it to an I+D circuit. The selected integrated correlation signal is applied to a S+H circuit. The signal is clocked through this S+H circuit with a selected timing signal and applied through a switch to the ADC. The digital output of the converter is applied to the multiplexer and is clocked out on the CRUIN line by the logic signals from the processor.

6.1.5.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE
Power	5VDC	160 ma	pwr sup
Power	-5VDC	27 ma	pwr sup
Power	12VDC	25 ma	pwr sup
Power	-12VDC	2 ma	pwr sup
RF	14.72MHz	TTL	FSM
RF	10MHz	TTL	CM
Timing	C/A epoch	TTL (1 msec epoch)	CGM
Timing	Data Clock	TTL (20 msec epoch)	CGM
Timing	1 MHz	TTL	CM
Timing	5 m TM	TTL (5 msec Timing Mark)	CM
Timing	100 KHz	TTL	CM
Timing	20 m TM	TTL (20 msec Timing Mark)	CM
Logic	M0	TTL (CRU address)	CRIM
Logic	M1	TTL (CRU address)	CRIM
Logic	M2	TTL (CRU address)	CRIM
Logic	B0	TTL (CRU address)	CRIM
Logic	B1	TTL (CRU address)	CRIM
Logic	B2	TTL (CRU address)	CRIM
Logic	L0	TTL (CRU address)	CRIM
Logic	L1	TTL (CRU address)	CRIM
Logic	L2	TTL (CRU address)	CRIM

Logic	CRUOUT	TTL (CRU data from processor)	CRIM
Logic	CRUCLK	TTL (CRU clock from processor)	CRIM
Logic	RXSEL	TTL (receiver select)	CRIM
Logic	DOLOCKA	TTL (lock detection bit)	NBM A
Logic	DOLOCKB	TTL (lock detection bit)	NBM B
Logic	HISLIPA	TTL (slip detection bit)	NBM A
Logic	HISLIPB	TTL (slip detection bit)	NBM B
Logic	LOSLIPA	TTL (not connected in NBM)	NBM A
Logic	LOSLIPB	TTL (not connected in NBM)	NBM B
Signal	CH1COR	Analog (correlation voltage)	NBM A
Signal	CH2COR	Analog (correlation voltage)	NBM B
Signal	DATA1	Analog (SV data)	NBM A
Signal	DATA2	Analog (SV data)	NBM B

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTIN.
Logic	CPDB0	TTL (decode address lines)	FSM
Logic	CPDB1	TTL (decode address lines)	FSM
Logic	CPDB2	TTL (decode address lines)	FSM
Logic	CPDACLOAD	TTL (D/A converter load pulse)	FSM
Logic	M700	TTL (decode bit)	CGM
Logic	CRUIN	TTL (data out of OM)	CM
Logic	CLTAU1	TTL (time constant control bit)	WBM
Logic	CLTAU2	TTL (time constant control bit)	WBM
Logic	CLTAU3	TTL (time constant control bit)	WBM

Logic	CLL1L2	TTL (bandpass filter control bit)	WBM
Logic	CLATT	TTL (attenuator control bit)	WBM
Logic	CLAGCTC11	TTL (AGC time constant control bit)	NBM A
Logic	CLAGCTC21	TTL (AGC time constant control bit)	NBM A
Logic	CLAGCSEL1	TTL (AGC control bit)	NBM A
Logic	CLAGCHOLD1	TTL (not used)	NBM A
Logic	CLQSWA	TTL (Q switch control bit)	NBM A
Logic	CLAGCTC12	TTL (AGC time constant control bit)	NBM B
Logic	CLAGCTC22	TTL (AGC time constant control bit)	NBM B
Logic	CLAGCSEL2	TTL (AGC control bit)	NBM B
Logic	CLAGCHOLD2	TTL (not used)	NBM B
Logic	CLQSWB	TTL (Q switch control bit)	NBM B
Logic	CLANTCTL	TTL (antenna control bit)	ANT SW
Logic	500CRUOUT	TTL (CRU data)	FSM
Logic	500L0	TTL (L field decode bit)	FSM
Logic	500L1	TTL (L field decode bit)	FSM
Logic	500L2	TTL (L field decode bit)	FSM

6.1.6 CODE GENERATOR MODULE

6.1.6.1 GENERAL DESCRIPTION

The Code Generator Module (CGM) is capable of generating a P-code and C/A-code replica under the control of the system processor. Codes are generated in various versions (early, late and prompt) and distributed to the Narrowband Module(s) to perform the correlation function. The CGM is primarily a CRU device which interfaces with the system processor via the RMBL address structure. All code control is exercised via the CRU interface and all responses by the various functions resident in the module are read by the processor via this interface.

6.1.6.2 FUNCTIONAL DESCRIPTION

The CGM can best be described by the functions that are performed while referring to its functional block diagram in Figure 6.1.6-1. The functions include: 1) code selection, 2) code initialization, 3) code starting, 4) code output/control, and 5) range data reading. A key item included in the CGM implementation is the Transfer Register (TR) utilized throughout various functions. This device is a 8-bit holding register (CRU latches) which is preset via processor control to route data to various sections of CGM hardware. This is accomplished by executing load commands associated with destination functions.

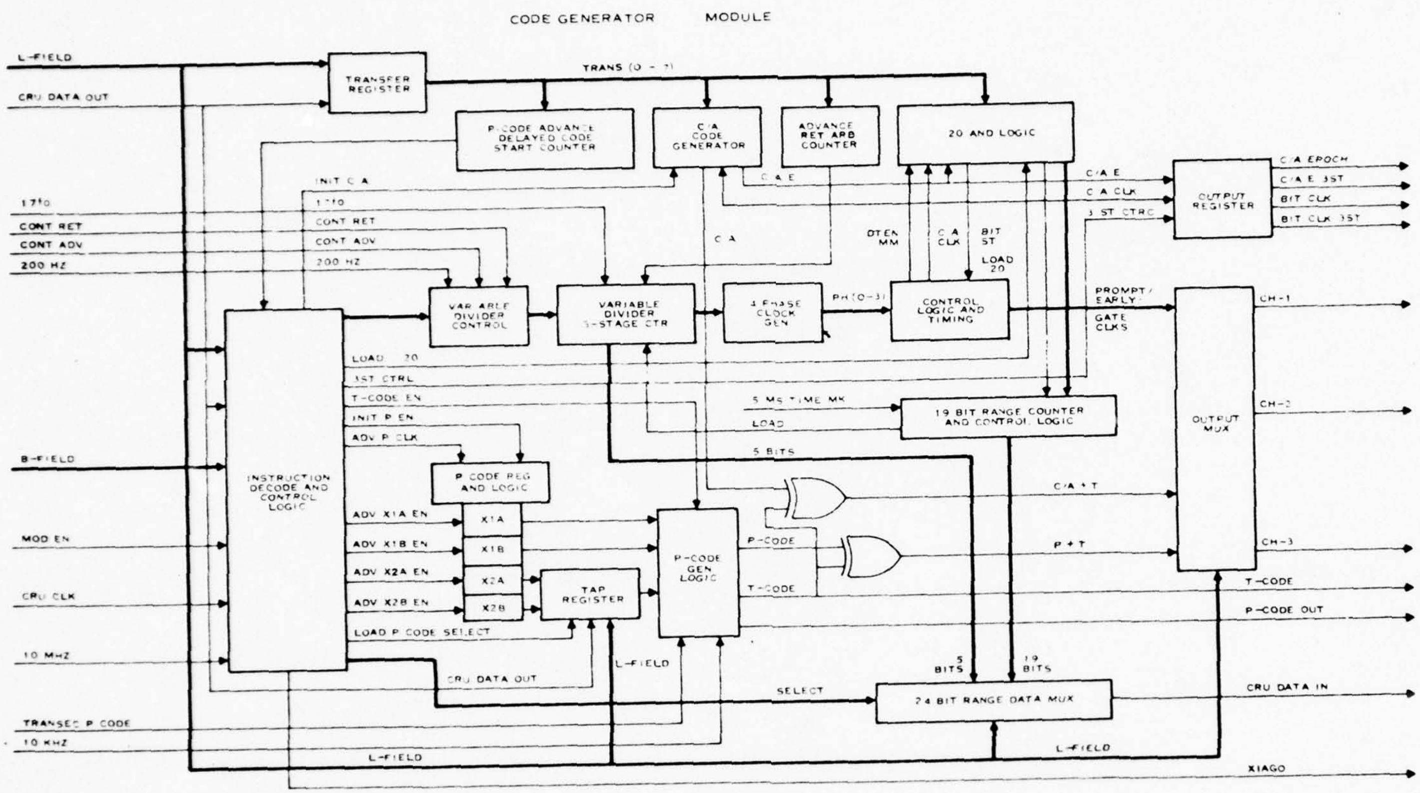

Figure 6.1.6-1. Functional Block Diagram

Code selection of C/A-code is accomplished by loading the appropriate bit pattern into the TR. The processor then executes a unique C/A-code load command via the CRU structure to load the bit pattern into the C/A-code generator. P-code selection is accomplished by again performing a CRU operation in the CGM's CRU space. The six bits are serially loaded into Tap Registers to define the phase relationship between the X1 and X2 registers of the P-code generator.

Code initialization is also a CRU operation. For C/A-code the processor executes a singular initiate command which forces the chip to the C/A EPOCH state. The generator remains in this state until other commands are issued.

P-code is initialized by first initializing the generator to the state associated with the beginning of the week via CRU operations. The four registers that form the P-code generator must each be advanced to appropriate states associated with the desired P-code state. The advance operation is accomplished by sequentially selecting one of the four registers to be advanced. The TR is then utilized to define the number of clocks to be advanced by presetting a P-Code Advance/Delayed Code Start Counter. The processor then enables the advance function which runs to completion automatically in 0.8 msec maximum. The next register is then selected to repeat the operation.

Code starting for the C/A-code is accomplished by executing a single CRU instruction. P-code can be started with two methods. Both methods require that C/A-code be initialized prior to P-code. The first method requires merely executing a CRU instruction to start the code. The second method involves a programmed delay start. The programmed delay is executed by loading delay information into the P-code Advance/Delayed Code Start Counter via the TR. The processor then arms the P-code generator via other CRU commands to start after the delay period has expired.

Code Output/Control deals with code alignment control and output buffering and selection. Code alignment control is intended to provide control over the code phase with respect to the received code. The control exercised is to either advance or retard the replica code phase in increments of 1/17 of a P-code chip. The task is accomplished by presetting the ADVANCE/RETARD Counter with the number of increments desired via the TR. The processor then executes the appropriate command to arm the Variable Divide 5-Stage Counter to the desired modulus (16 for advance or 18 for retard). The loading of the MSB's into the ADVANCE/RETARD Counter also starts the advance or retard operation.

The C/A-code circuitry generates an output pulse (C/A epoch) at the end of each cycle. These pulses drive the Divide-By-20 Counter which generates a pulse output each

time the counter modulos. The processor must align the occurrence of the resulting 50-Hz pulse with the data bit changes. It accomplishes this alignment by changing the contents of the Divide-by-20 Counter, thus changing the time at which the next modulo occurs. The 5-bit counter value is output to the TR and then to a CRU output to load the Divide-By-20 Counter.

Code output selection is accomplished via the Output Multiplexer section which allows the processor to select various code versions with CRU controls. The code generator creates three versions of C/A-code and P-code. These code versions are early, late, and prompt. The early and late C/A versions are 38/170 of a C/A-code chip before and after prompt while the P versions are 4/17 of a P-code chip before and after prompt. The processor may select one of these six versions to be outputted to each of three outputs from the Output Multiplexer section. The processor may also enable a "code flop" function which involves arming the Output Multiplexer with two sets of select commands to control output code. The processor may then enable the code flop command which forces output control to be alternated on 20-msec time marks between the two sets of commands.

The CGM provides a P-code output that can be enabled to a "scrambler" for use in a secure environment. The scrambled P-code, called TRANSEC, can be enabled to the output selection logic by performing the appropriate CRU operation.

During built-in-testing, the BITM will modulate an X1-code onto the test signals. The processor commands the CGM to output an X1-code instead of the full P-code.

To overcome mixer leakage problems in the presence of CW jamming, the processor may enable the T-code by performing a CRU output. The T-code will modulate the code stream (and a 10-MHz offset signal) in a pseudo random fashion.

Range data reading is accomplished by performing a CRU operation to obtain the contents of two counters resident in the module. The counters include the Variable Divider 5-Stage Counter and the 19-bit Range Counter. The counters count the number of 17-Fo cycles between the data clock and a 20-msec timing pulse provided by the system master oscillator. This information is the pseudo-range.

6.1.6.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
RF	17Fo	ECL	FSM
Power	5.0 VDC	1.2a	pwr sup
Clock	20ms Time Mark	TTL (Fundamental Time Frame (FTF))	CM
Clock	10KHZ	TTL (100-ms Time Marks)	CM
Logic	B0-B2	TTL (Bit field of processor address bus)	MPM
Logic	L0-L2	TTL (Latch field of processor address bus)	MPM
Logic	MODEN	TTL (Module Enable)	OM
Logic	CRU CLK	TTL (CRU Clock)	MPM
Logic	CRU DATA OUT	TTL (CRU serial Data Out)	MPM
Clock	10 MHz	TTL (10-MHz clock)	CM
Logic	T/S Pcode	Transformed Secure P-Code	not used
Logic	ADVANCE	TTL (P-code Advance command)	not used
Logic	RETARD	TTL (P-code Retard command)	not used
Logic	Ext DHO Syn	TTL (External Direct Handover Synchronization pulse)	EIOM (MVUE)

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTIN.
Clock	T-code	TTL (10-KHz PRN sq wave)	FSM
Clock	Data Clock	TTL (50-Hz pulse stream, in sync with incoming signal)	OM
Data	CRUIN	TTL (CRU serial data)	MPM
Logic	C/A EPOCH	TTL (C/A-CODE epoch)	OM, FSM
Logic	X1AGO	TTL (X1A register epoch)	BITM
Data	Code 1,2,3	TTL (output multiplexer code ouput)	NBM

6.1.7 BUILT-IN-TEST MODULE

6.1.7.1 GENERAL DESCRIPTION

The Built-In-Test Module (BITM) generates seven test signals which are distributed to other parts of the system for calibration and fault isolation functions. The module is capable of generating L1 and L2 pseudo-replicas along with other lower frequency signals which are compatible with other inputs within the system to allow fault isolation. The term pseudo-replicas is used above since a complete L1 and L2 is not generated. The only code available is the X1-code from the P-code registers associated with P-code generation. Data for the RF carrier is only the Barker Code associated with the 50-Hz subframes.

The BITM is a CRU device which interfaces with the system processor via the RMBL address structure. The module can be controlled via this interface and is capable of accepting TTL status information to be read by the system processor for fault isolation.

6.1.7 FUNCTIONAL DESCRIPTION

As shown in Figure 6.1.7-1, the BITM is subdivided into three major areas: 1) RF generation, 2) code generation, and 3) processor interface.

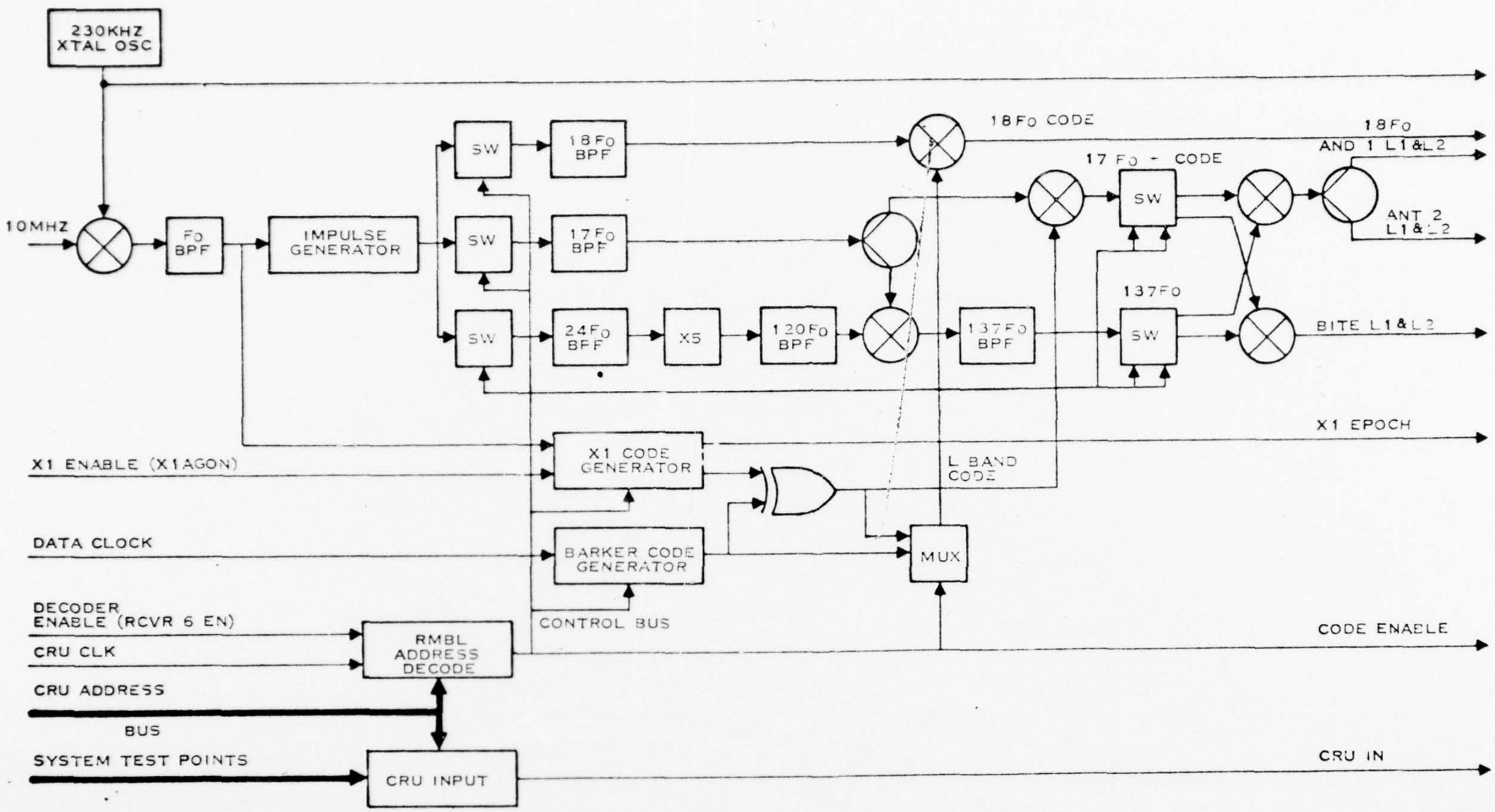

Figure 6.1.7-1. Function Block Diagram Built-In Test Module

The RF generation area generates a series of RF signals for system distribution. The signals include 18-Fo for the Narrowband Module input, BITE L1 and L2 for Wideband Module input, and 230 KHz for Output Module input. All BITE RF signals are sourced by an Fo generator which is derived by mixing an external 10-MHz signal (from the Master Oscillator in the system) with a signal from a 230-KHz crystal oscillator. The sum signal is filtered in a 10.23-MHz crystal filter and amplified in the Fo bandpass filter. The Fo signal is then routed to an impulse generator which is a squaring amplifier providing a signal rich in harmonics.

The squared signal is routed to three filter sections. The first section is the 18-Fo section which amplifies and filters the eighteenth harmonic. The filtered signal is then mixed with 18-Fo code to form the 18-Fo BIT signal for the Narrowband Modules. The second and third sections are closely intertwined to generate the BIT L1 and L2 signals. The second section is the 17-Fo section which filters and amplifies the seventeenth harmonic. The filtered 17-Fo signal version is routed to a power splitter. One output from the power splitter is forwarded to a mixer to be mixed with L-Band code. The third section is the 120-Fo section which involves filtering and amplifying the 24th harmonic (24-Fo) and multiplying by a factor of 5 to obtain 120-Fo, which is in turn filtered and

amplified again. This 120-Fo signal is forwarded to a mixer to be mixed with the second output of the 17-Fo power splitter. The summation signal (137-Fo) is filtered and amplified in the 137-Fo band pass filter. Two key signals have been established. They are the 17-Fo signal with L-Band code and the 137-Fo signal. Each signal is routed to an RF switch. The control signals to these switches can either enable or inhibit the two outputs from each switch section. The outputs from each switch section are routed to two mixers which generate sum and difference signals (120-Fo or L2, and 154-Fo or L1). The output of one mixer is routed out of the module to the Wideband Module, while the output of the other mixer is forwarded to a power splitter that provides the Antenna BIT signals. The latter signals are used for calibration that encompasses any hardware prior to the Wideband Module, such as preamplifiers and cables.

The code generation area is primarily digital. The X1-CODE is generated under control of the system processor. The processor exercises initialization control over the code generator to reset and arm the generator. The X1-code generator is driven by an Fo version clock once the X1 enable signal is activated to allow generator operation. The Barker Code Generator is also reset and armed via the processor. This

generator is driven by an external 50-Hz data clock. The outputs of the X1-Code Generator and the Barker Code Generator are exclusive OR'ed to form the L-Band Code version that is mixed with the 17-Fo signal. The L-Band Code and the Barker Code are routed to a multiplexer. The output of the multiplexer (18-Fo Code) can be either L-Band Code or Barker Code, depending on the selection made via the processor.

The hardware in the processor interface is primarily digital to interface with the processor. The RMBL Address Decode hardware is processor CRU output logic designed to control the various functions within the module. RF signals are enabled or disabled at various points, and code generation control and initializations are performed via this interface. The CRU input logic accepts status inputs from external sources to be input to the processor via CRU operations.

6.1.7.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
Power	5.2 V RF	125 ma	pwr sup
Power	- 5.0 VDC	10 ma	pwr sup
Power	12.0 VDC	145 ma	pwr sup
Logic	X1A START	TTL (X1-Code Generator enable)	CGM
Data	CRU OUT	TTL (serial CRU data)	MPM
Data	/LO-/L2	TTL (Latch field of processor Address Bus)	MPM
Data	/BO-/B2	TTL (Bit field of processor Address Bus)	MPM
Logic	RCVR gen	TTL (RMBL address decode enable)	MPM
Logic	/CRUCL	TTL (CRU Clock strobe)	MPM
Logic	DATACLK	TTL (50-Hz Data Clock)	CGM
RF	10MHZ	TTL (10-MHZ reference)	ref osc

II. Outputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	DESTIN.
Logic	230KHZ	TTL (buffered)	NBM
Logic	Code	TTL (Narrowband code enable)	NBM
RF	18Fo	-30 dBm	WBM
RF	BITE 154Fo	-50 dBm	WBM
RF	Ant1 + 2	1575.42 MHZ and 1227.6 MHZ at -15 dBm	ext preamp

6.1.8 REFERENCE OSCILLATOR

6.1.8.1 GENERAL DESCRIPTION

The reference oscillator contains a stable 10-MHz source and associated circuitry.

6.1.8.2 FUNCTIONAL DESCRIPTION (refer to Figure 6.1.8-1)

I. 10MHz Oscillator

The oscillator is a HP10544A with a voltage regulator on it's input voltage. The output signal is a minimum of 1 VRMS sinewave with an output impedance of 1 K ohm from an AC coupled (0.01 uf) emitter follower.

II. Voltage Regulator

15VDC is reduced to 12VDC with two regulator circuits. The output of one of these supplies voltage for the reference oscillator. The second supplies the voltage for the heater controller within the oscillator case.

Heater voltage for the reference oscillator is from 28VDC fed through a line filter.

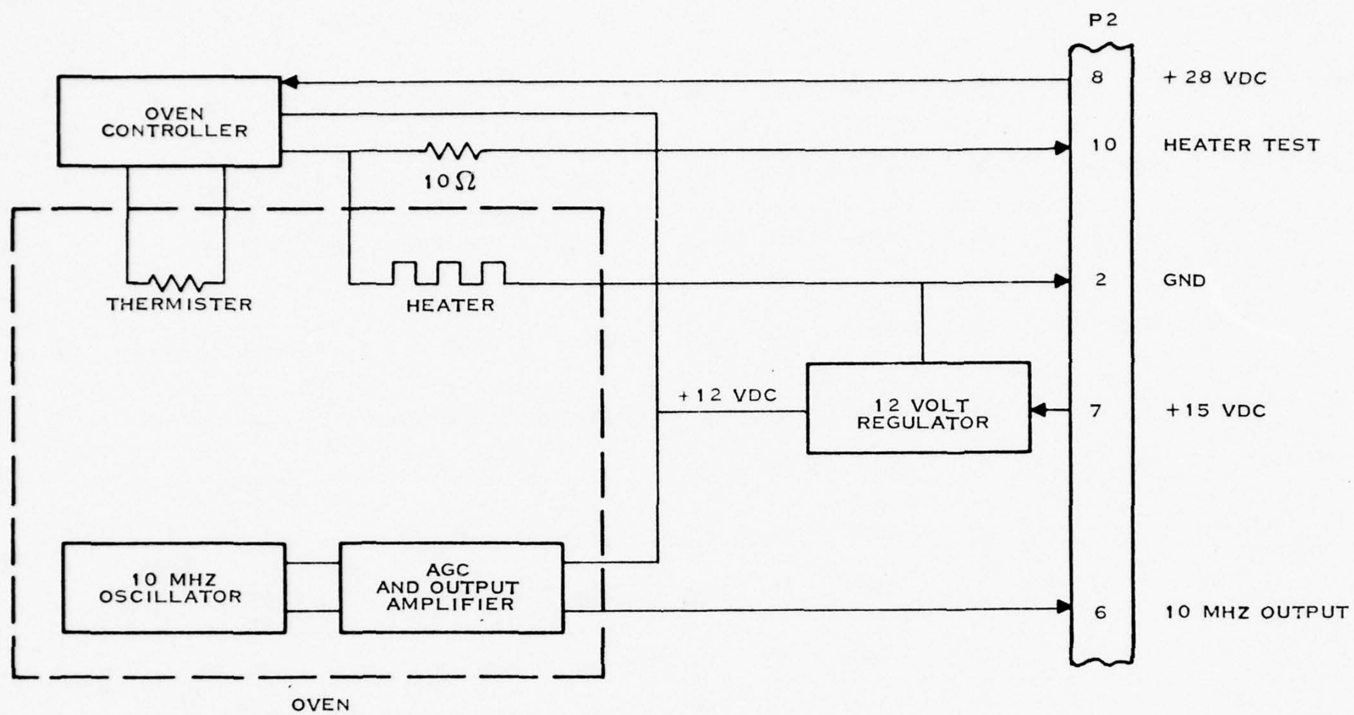

Figure 6.1.8-1. Functional Block Diagram Reference Oscillator

6.1.9.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE
Power	15VDC	0.33 w	Pwr sup
Power	28VDC	15.4 w during warm-up 2.94 w after warm-up	AC/DC Conv

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTIN.
RF	10MHz	1 VRMS sinewave	CM

6.2 PROCESSOR SECTION

6.2.1 MICROPROCESSOR MODULE

6.2.1.1 GENERAL DESCRIPTION

The Microprocessor Module (MPM) provides computational and functional control capability for the system. Information transfers between the microprocessor and memory for instruction fetch operations and data storage/retrieval operations is accomplished by a bi-directional memory bus under microprocessor control. Input/output functions for the microprocessor are accomplished by the direct instruction driven interface designated as a Communication Register Unit (CRU) interface. A direct memory access (DMA) capability is implemented such that the microprocessor releases control and/or data signals to affect the transfer between the external device and memory.

6.2.1.2 FUNCTIONAL DESCRIPTION (refer to Figure 6.2.1-1)

From the block diagram shown in Figure 6.2.1-1, the MPM consists of a microprocessor, address decode logic, read-only memory (ROM), ROM power switching circuitry, read/write random access memory (RAM), clock generation logic, output buffer logic, and input buffer logic.

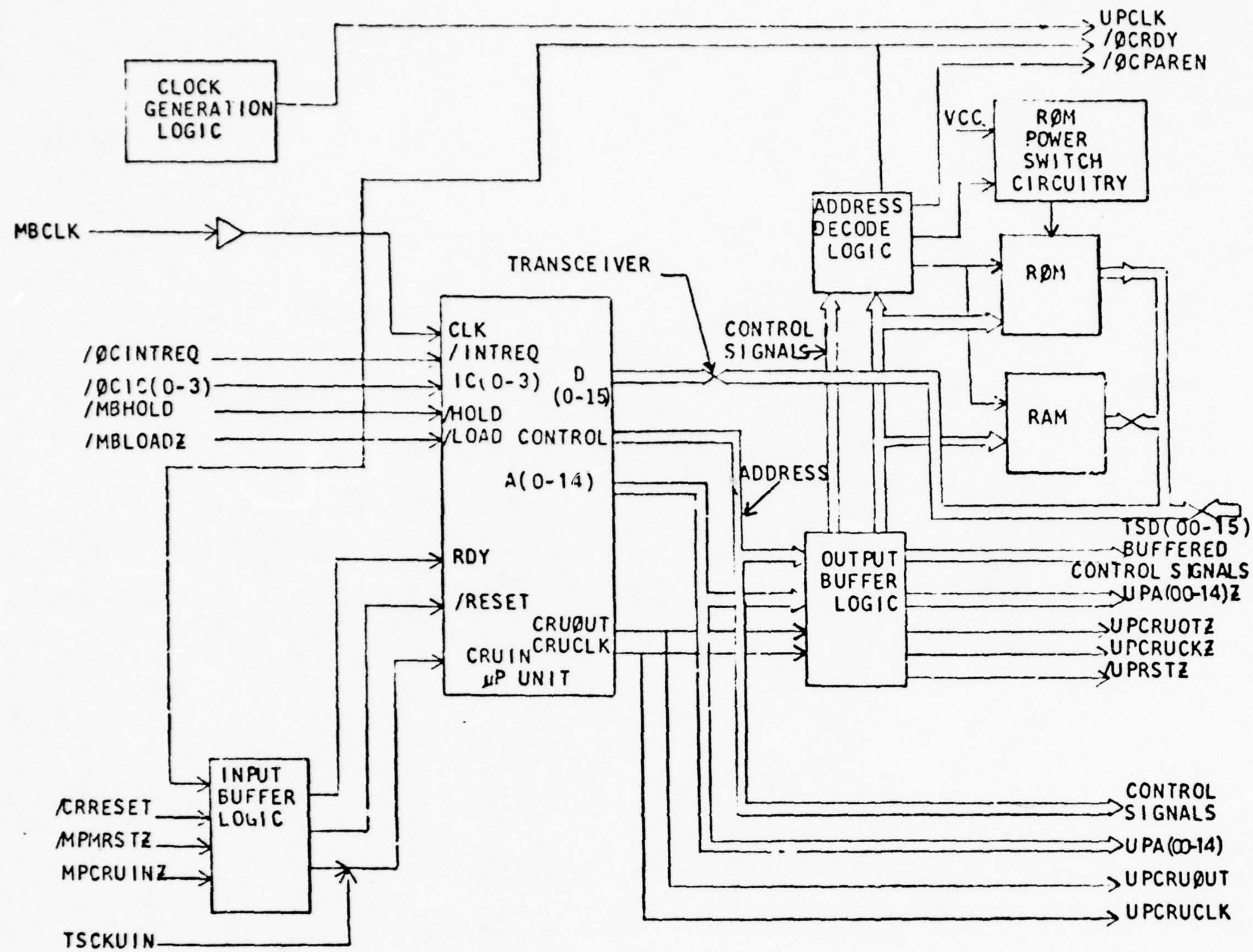

Figure 6.2.1-1. Functional Block Diagram Microprocessor Module

Table 6.1.13-1. Instruction Set

ALPHABETIC LIST OF ASSEMBLY LANGUAGE INSTRUCTIONS

Mnemonic	Operands	OP Code	Instruction
A	G,G<=	A000	ADD (WORD)
AB	G,G<=	B000	ADD (BYTE)
ABS	G, -	0740	ABSOLUTE VALUE
AI	WR<=,I	0220	ADD IMMEDIATE
ANDI	WR<=,I	0240	AND IMMEDIATE
B	G	0440	BRANCH
BL	G	0680	BRANCH AND LINK (W11)
BLWP	G	0400	BRANCH; LOAD WORKSPACE POINTER
C	G,G	8000	COMPARE (WORD)
CB	G,G	9000	COMPARE (BYTE)
CI	WR,I	0280	COMPARE IMMEDIATE
CKOF	----	03C0	CLOCK OFF (NOTES 1,3)
CKON	----	03A0	CLOCK ON (NOTES 1,3)
CLR	G	04C0	CLEAR OPERAND
COC	G,WR	2000	COMPARE ONES CORRESPONDING
CZC	G,WR	2400	COMPARE ZEROES CORRESPONDING
DEC	G	0600	DECREMENT BY ONE
DECT	G	0640	DECREMENT BY TWO
DIV	G,WR<=	3C00	DIVIDE
IDLE	----	0340	COMPUTER IDLE (NOTE 1,3)
INC	G	0580	INCREMENT BY ONE
INCT	G	05C0	INCREMENT BY TWO
INV	G	0540	INVERT
JEQ	PC	1300	JUMP ON EQUAL (ST BIT 2=1)
JGT	PC	1500	JUMP GREATER THAN (ST BIT 1=1)
JH	PC	1B00	JUMP HIGH (ST BITS 0=1 AND 2=0)
JHE	PC	1400	JUMP HIGH OR EQUAL (ST BIT 0=1 OR 2=1)
JL	PC	1A00	JUMP LOW (ST BITS 0=0 AND 2=0)
JLE	PC	1200	JUMP LOW OR EQUAL (ST BIT 0=0 OR 2=1)
JLT	PC	1100	JUMP LESS THAN (ST BITS 1=0 AND 2=0)
JMP	PC	1000	JUMP UNCONDITIONAL
JNC	PC	1700	JUMP NO CARRY (ST BIT 3=0)
JNE	PC	1600	JUMP NOT EQUAL (ST BIT 2=0)
JNO	PC	1900	JUMP NO OVERFLOW (ST BIT 4=0)
JOC	PC	1800	JUMP ON CARRY (ST BIT 3=1)
JOP	PC	1C00	JUMP ODD PARITY (ST BIT 5=1)
LDCR	G,NOTE 4	3000	LOAD CRU (NOTE NINE)
LDD	G	07C0	LONG DISTANCE DESTINATION (NOTE 1,2)
LDS	G	0780	LONG DISTANCE SOURCE (NOTE 1,2)
LI	WR<=, I	0200	LOAD IMMEDIATE
LIMI	I	0300	LOAD INTERRUPT MASK IMMEDIATE (NOTE 1)
LMF	WR NOTE 5	0320	LOAD MAP FILE (NOTE 1,2)
LREX	----	03E0	LOAD ROM AND EXECUTE (NOTE 1,3)
LWPI	I	02E0	LOAD IMMEDIATE TO WORKSPACE POINTER
MOV	G,G<=	C000	MOVE WORD
MOVB	G,G<=	D000	MOVE BYTE
MPY	G,WR<=	3800	MULTIPLY
NEG	G	0500	NEGATE (TWO'S COMPLEMENT)
ORI	WR<=,I	0260	OR IMMEDIATE
RSET	----	0360	RESET AU (NOTE 1,3)
RTWP	----	0380	RETURN FROM SUBROUTINE (NOTE 8)
S	G,G<=	6000	SUBTRACT WORD
SB	G,G<=	7000	SUBTRACT BYTE
SBO	CRU	1D00	SET CRU BIT TO ONE (NOTE 9)
SBZ	CRU	1E00	SET CRU BIT TO ZERO (NOTE 9)
SETO	G	0700	SET ONES
SLA	WR<=,NOTE 6	0A00	SHIFT LEFT ARITHMETIC
SOC	G,G<=	E000	SET ONES CORRESPONDING (WORD)
SOCB	G,G<=	F000	SET ONES CORRESPONDING (BYTE)
SRA	WR<=,NOTE 6	0800	SHIFT RIGHT (MSB EXTENDED)

ALPHABETIC LIST OF ASSEMBLY LANGUAGE INSTRUCTIONS (Continued)

Mnemonic	Operands	OP Code	Instruction
SRC	WR<=,NOTE 6	0B00	SHIFT RIGHT CIRCULAR
SRL	WR<=,NOTE 6	0900	SHIFT RIGHT LOGICAL
STCR	G<=,NOTE 4	3400	STORE FROM CRU (NOTE 9)
STST	WR	02C0	STORE STATUS REGISTER
STWP	WR	02A0	STORE WORKSPACE POINTER
SWPB	G	06C0	SWAP BYTES
SZC	G,G<=	4000	SET ZEROES CORRESPONDING (WORD)
SZCB	G,G<=	5000	SET ZEROES CORRESPONDING (BYTE)
TB	CRU	1F00	TEST CRU BIT (NOTE 9)
X	G	0480	EXECUTE
XOP	G,NOTE 7	2C00	EXTENDED OPERATION
XOR	G,WR<=	2800	EXCLUSIVE OR

<= INDICATES THE ADDRESS INTO WHICH THE RESULTS ARE PLACED WHEN 2 OPERANDS ARE SPECIFIED.

NOTES

1. PRIVILEGED INSTRUCTION – MODEL 990/10
2. MODEL 990/10 WITH MAP OPTION ONLY
3. NOT IMPLEMENTED IN THE TMS 9900
4. THE SECOND OPERAND IS THE NUMBER OF BITS TO BE TRANSFERRED, 0-15 (0=16)
5. THE SECOND OPERAND SPECIFIES A MEMORY MAP FILE -0 OR 1.
6. THE SECOND OPERAND IS THE SHIFT COUNT, 0-15. 0 MEANS THE COUNT IS IN BITS 12-15 OF WORKSPACE REGISTER 0. WHEN COUNT =0 AND BITS 12-15 OF WORKSPACE REGISTER 0 = 0, SHIFT COUNT IS 16.
7. SECOND OPERAND SPECIFIES THE EXTENDED OPERATION, 0-15 DISPOSITION OF THE RESULT MAY OR MAY NOT BE IN OPERAND ONE, AS DETERMINED BY THE USER.
8. WHEN PRIVILEGED INSTRUCTION BIT (7) OF THE STATUS REGISTER IS SET, ONLY BITS 0-6 ARE RETURNED TO THE STATUS REGISTER BY RTWP.
9. WHEN PRIVILEGED INSTRUCTION BIT (7) OF THE STATUS REGISTER IS SET, CRU ADDRESSES GREATER THAN >E00 (INCLUDING EXPANSION CHASSIS 7) ARE ILLEGAL.

A complete list of the microprocessor instruction set is shown in Table 6.2.1-1. Data and control interfaces are described as follows:

I. Memory interface

To accomplish transfers between the microprocessor and memory, the microprocessor provides a 15-bit address on the memory address bus along with the necessary memory control signals. Memory data to or from the microprocessor is transferred via a 16-bit bi-directional data bus. The direction of the data flow on the data bus is controlled by the microprocessor. The addresssed memory is either the memory contained on the MPM or memory external to the MPM. The memory interface also provides the capability for the microprocessor to relinquish control of the memory interface to an external device. Upon request by the external device, the microprocessor permits the external device to control the memory bus such that it transfers directly between the external device and memory. During such operations, the external device provides the necessary memory address and control signals. Upon completion of its transfers, the external device removes its request, and control of the memory bus is reverted to the microprocessor.

II. CRU interface

The microprocessor has the capability of serially transferring data to or from an external device by utilizing its CRU interface. The transfers are performed under microprocessor instruction control. The instruction type determines the number of bits to be transferred (from one bit to 16 bits) and the direction of the data transfer. To perform transfers, the microprocessor provides a unique 12-bit address on the address bus for each bit to be transferred. If the data bit(s) is to be an output from the microprocessor, the microprocessor provides the output data on the CRU output signal line and a clock pulse on the CRU clock signal line. If the data is an input to the microprocessor, the addressed external device reponds by placing input data on the CRU input signal line. No CRU clocks are provided by the microprocessor during CRU input operations.

III. Maintenance panel interface

The microprocessor interfaces to the maintenance panel (MP) to permit MP user to input data into the microprocessor or memory, or perform a breackpoint operation. Input data is entered via switches on the MP and read into the microprocessor or memory by executing a CRU input instruction with the appropriate address. Data to be displayed on the MP is outputted

to the MP by executing a CRU output command with the appropriate CRU address. The breakpoint function permits the user to select, via switches on the MP, a breakpoint memory address or mode and upon coincidence of these with the microprocessor memory address and mode, the microprocessor stops execution and reverts to the execution of MP firmware.

IV. Interrupt interface

The microprocessor has the capability to accept up to 15 external interrupts. Upon receipt of an interrupt request signal and a 4-bit encoded interrupt code, the microprocessor performs a context switch, provided the received interrupt code is less than or equal to the interrupt mask in the microprocessor. If not, the interrupt request is ignored until the above condition is satisfied.

6.2.1.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTICS	SOURCE
Power	5 VDC	1.5 a	pwr sup
Power	1.5 VDC	750 ma	
Logic	/MBHOLD	TTL (to halt MPM for DMA)	DMM
Logic	/OCRDY	TTL (memory ready status)	DMM
Data	MPCRUINZ	Tri-state (MP serial input data)	MP
Logic	MPLOADZ	TTL (non-maskable interrupt to MP load routine)	MP
Logic	MPMRSTZ	TTL (zero level non-maskable interrupt to reset MPM)	MP
Logic	/OCINTREQ	TTL (interrupt request)	CRIM
Logic	/OCIC(0-3)	TTL (interrupt code)	CRIM
Logic	MBCLK	TTL (MPM instruction cycle clock)	MPM

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTICS	DESTIN.
Logic	UPA(00-14)B	Tri-state (memory address bus)	DMM
Logic	/UPMEMENB	Tri-state (valid memory address)	DMM
Data	TSCRUIN	Tri-state (CRU serial input data)	MPM
Logic	/UPDBINB	Tri-state (to disable output buffers)	DMM
Logic	/UPWE	Open-collector (write enable)	DMM
Logic	UPIAQB	Tri-state (memory instruction fetch)	DMM
Logic	/UPENDCY	Open-collector (end of present memory operation)	DMM
Logic	UPSEOC	TTL (synchronized end-of-cycle	DMM
Logic	/OCPAREN	TTL-DR (parity enable for RAM)	DMM
Logic	UPHOLDA	Open-collector (MPM hold acknowledge)	DMM
Logic	/UPWAIT	Open-collector (MPM in WAIT state)	DMM
Data	UPCRUOUT	TTL (CRU serial output data)	OM, CGM
Logic	UPCRUCLK	TTL (CRU data clock)	OM, CGM
Data	UPA(00-14)Z	TTL (MP address bus)	MP
Data	UPCRUOUTZ	TTL (MP serial data out)	MP
Logic	UPCRUCKZ	TTL (MP serial data clock)	MP
Logic	/UPMEMENZ	TTL (MP valid memory address)	MP
Logic	UPDBINZ	TTL (MP disable output buffer)	MP
Logic	UPIAQZ	TTL (MP instruction fetch)	MP

Logic	UPENDCYZ	TTL (MP end-of-cycle)	MP
Logic	UPRSTZ	TTL (MP reset)	MP
Analog	UPVCCSAM	5 VDC (status)	MP
Logic	UPCLK	TTL-DR (clock output source	MP
Logic	UP8.25 mh	TTL-DR (cycle clock output)	MPM
Logic	UPBDBIN	TTL (output buffer disable)	MP
Logic	UPRWRDY	TTL (read/write ready)	MPM
Logic	UPRWOE	TTL (enable RAM output)	DMM
Logic	UPRWWE	TTL (write operation)	DMM

III. Bi-directional

CATEGORY	SIGNAL NAME	CHARACTERISTICS	SOURCE/ DESTIN.
Data	TSD(00-15)	Tri-state (data bus)	DMM

6.2.2 COMMUNICATION REGISTER INTERFACE MODULE

6.2.2.1 GENERAL DESCRIPTION

The Communication Register Interface Module (CRIM) performs a number of processor related functions. The functions include interrupt encoding, processor CRU decoding, address bus buffering, system reset control, and parity bit generation and verification for the system.

6.2.2.2 FUNCTIONAL DESCRIPTION

The CRIM is functionally shown in Figure 6.2.2-1.

The Interrupt Control Logic is tasked with accepting a maximum of 8 external interrupt stimuli from the system and priority encoding the information for the system processor. Via the CRU function the processor may selectively mask off discrete interrupt inputs when the system warrants this feature.

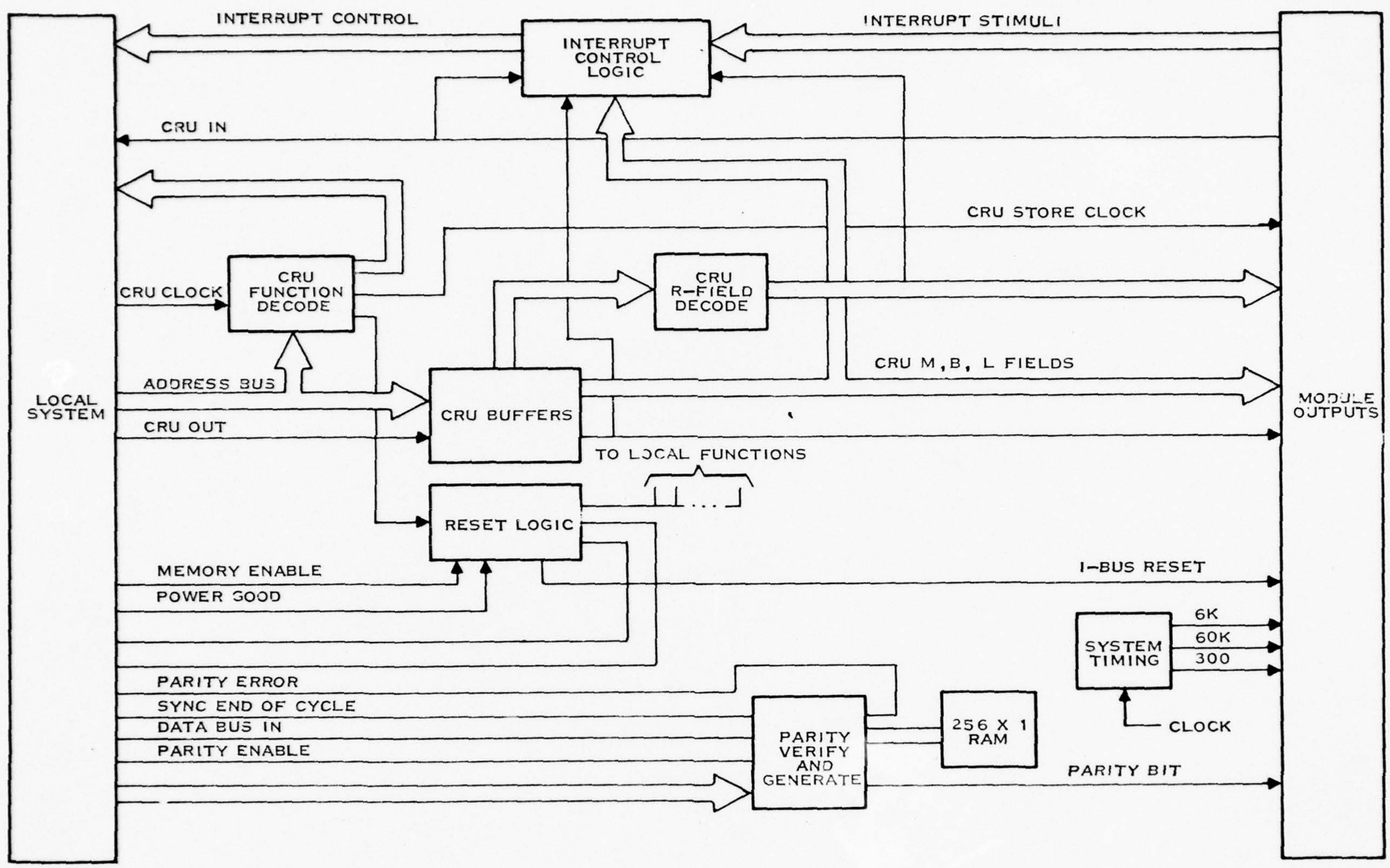

Figure 6.2.2-1. Functional Block Diagram Communication Register Interface Module

The CRU R-Field Decode section is tasked with decoding bits 03 thru 05 (R-Field of Address Bus) to define one of 8 CRU receiver spaces to be addressed for CRU control. These decoded signals are utilized in systems having more than one receiver channel. The CRU Function Decode section provides a set of decodes for special system functions. These special functions include IDLE, CLKON, and RESET which are special states that the processor could assume.

The CRU Buffers buffer the system address to route the M, B, and L Fields of the Address Bus to the system.

The Reset Logic section generates reset commands for various applications. The Power Good input to this section results in a level 0 (unmaskable) interrupt to the system processor to initialize the entire system (software and hardware). Software may also generate reset commands via instructions dedicated for this task.

The Parity verify and generate section generates an odd parity bit as a function of bits on the Data Bus. The resultant Parity Bit is routed off the CRIM module to be stored in system memory. During a read operation when parity is verified a parity error may be generated to be routed to the system for disposition. The CRIM unit is also equipped with RAM storage for parity bits generated for 256 addresses in high memory space.

6.2.2.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
Power	+5VDC	900 ma	pwr sup
Logic	/OCPAREN	Open-collector (indicates that parity needs to be checked or generated)	system memory
Logic	UPSEOC	TTL (Memory End of Cycle. Active during last cycle of any memory operation)	MPM
Logic	UPDBIN	TTL (denotes when processor is executing a read operation)	MPM
Data	/I(1-7)	TTL (Interrupt stimulus input)	system
Logic	/ICAS (8)	TTL (highest priority Interrupt)	system
Logic	UPWAIT	TTL (denotes when processor is in wait state because of a not ready condition from memory)	MPM
Logic	PSPG	TTL (Power Supply Power Good)	pwr sup
Data	UPA(0-14)	TTL (Processor Address Bus)	MPM
Logic	UPCRUCLK	TTL (Processor CRU Clock)	MPM
Data	UPCRUOUT	TTL (Processor CRU serial output data)	MPM
Logic	/UPMEMEN	TTL (Denotes when processor is executing a memory operation (read or write)	MPM

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTIN.
Logic	/CRPARERR	TTL (denotes that a read parity error has occured)	MPM
Logic	/OCINTREQ	Open-collector (denotes that an interrupt is pending)	MPM
Data	/OCIC(1-3)	Open-collector (encoded interrupt code indicates code associated with interrupt pending)	MPM
Logic	/OCRDY	Open-collector (delayed wait from processor)	system
Data	TSCRUIN	Tri-State (serial CRU data)	MPM
Data	/CRM(0-2)	TTL (Module field of address bus)	system
Data	/CRL(0-2)	TTL (Latch field of address bus)	system
Data	/CRB(0-2)	TTL (Bit field of address bus)	system
Data	/CRR(0-7)	TTL (decoded Register field of address bus)	system
Data	/CRA(3-5)	TTL (Register field of address bus)	system
Logic	/CRSTORCK	TTL (gated Store Clock from MPM)	MPM

III. Bi-directional

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE/ DESTIN.
Data	TSD(00-15)	TTL (System Data Bus)	MPM
Logic	TSPAR	Tri-state (Parity bit generated by the system as well as the bit generated by the CRIM unit during write operation)	system memory

6.2.3 DATA MEMORY MODULE

6.2.3.1 GENERAL DESCRIPTION

The Data Memory Module (DMM) is a Random Access Memory module with capabilities to both read and write 4096 17-bit words. The module can be programmed to respond to any 4K memory space within a 20-bit address space.

6.2.3.2 FUNCTIONAL DESCRIPTION (refer to Figure 6.2.3-1)

As shown in Figure 6.2.3-1 the DMM is designed to interface onto a processor Data Bus and Address Bus. The Data Bus is a 17-bit bus which either is connected directly to the 4096 Memory Array for write operations, or is connected to the Output Data Buffer section. These output buffers are operable during a read operation from the Memory Array under the control of the Data Bus IN/READ command from the system. The Address Bus is a 20-bit address bus which is subdivided into three sections. The five MSB's of the address bus are utilized to define which of 32K memory sectors this module is to be located in when system requirements are greater than 32K. The next 4 MSB's are utilized to define where within a 32K memory space the 4K module will reside. The last 11 LSB's are utilized to address the Memory Array itself. The Module Select section generates all module enable commands derived from the 9 MSB'S of the address bus, while the Address Buffer section drives the Memory Array.

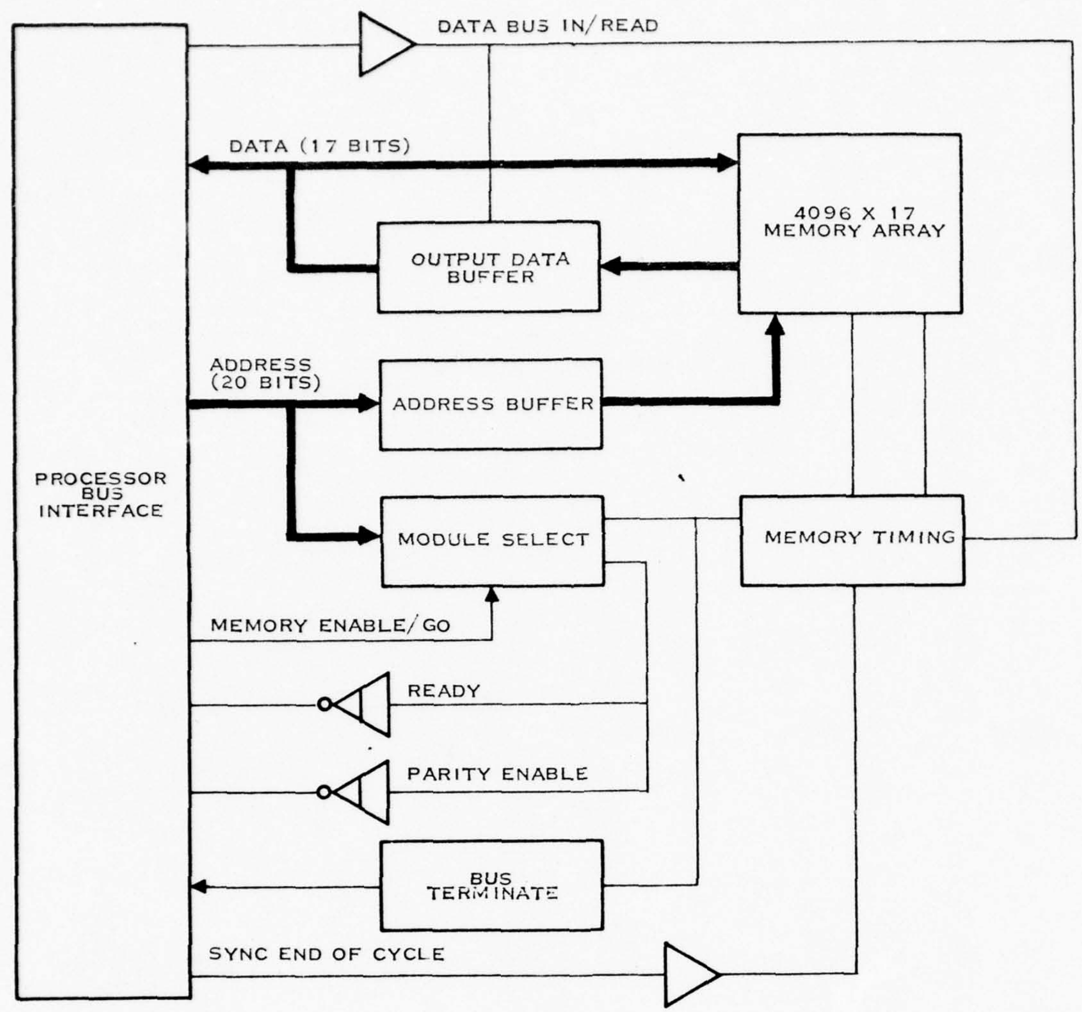

Figure 6.2.3-1. Functional Block Diagram Data Memory Module

The READY and PARITY enable signals generated by the Module Select section serve to interface with the system to satisfy the proper handshake requirements. The Bus Terminate section serves to allow interfacing with the I-BUS. This section generates a terminate status when either a read or write operation has been concluded on the DMM. The Memory Timing section is primarily a combinational logic block which controls read or write timing to the Memory Array.

6.2.3.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE
Power	5 VDC	300 ma	pwr sup
Power	-5 VDC	50 ma	pwr sup
Power	12 VDC	300 ma	pwr sup
Data	TLAD(0-14)	TTL (system Address bits utilized to address within a 32K boundary)	MPM
Data	MSS(0-3)	TTL (Memory Sector Select inputs to define which 32K boundary a module is to occupy.)	system selects
Data	TLDAT 16	TTL (parity Data bit)	CRIM
Logic	MEMEN or TLGO	TTL (indicates that a memory operation is in progress)	MPM
Logic	TLREAD or UPDBIN	TTL (defines a Read operation when a memory function is in progress)	MPM
Logic	UPSEOC	TTL (enables data onto output data bus. Signal is active during last cycle of memory operation.)	MPM
Logic	DMLWR	TTL (enables data to be written into the memory array)	MPM

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTIN.
Logic	OCRDY	TTL (indicates that the addressed memory is ready to read or write)	MPM
Logic	OCPAREN	TTL (indicates that parity needs to be checked or generated on the Parity Data Line)	CRIM
Logic	TLTM	TTL (denotes when the memory device has completed a read or write operation)	I-BUS

III. Bi-directional

CATEGORY	SIGNAL NAME	CHARACTERISTIC	SOURCE/ DESTIN.
Data	TLDAT(O-15)	TTL (Data bus bits)	MPM

6.2.4 PROGRAM MEMORY MODULE

6.2.4.1 GENERAL DESCRIPTION

The Program Memory Module (PMM) is a Read Only Memory module with capabilities to only 16,384 16 bit words. Each module can be programmed such that it can respond to addressing within a 20 bit address space.

6.2.4.2 FUNCTIONAL DESCRIPTION

As shown in Figure 6.2.4-1 the PMM is designed to interface onto a processor bus eiher local or I-bus. This interfacing is accomplished via the Data Bus, Address Bus, and key interface commands. The three MSB of the Address Bus are decoded in the Address Decoding section. A user may program (via the Programmable Enables and the Higher Order Address Bits) the module to operate in the desired 16K space of a total 20 bit address space. The 12 LSBS of the Address Bus are buffered to drive the memory array. The Memory Timing section accepts key interface commands to control the timing involved in addressing the Memory Array properly. The PROM Memory Array is composed of 32 (2048 x 4 bit) PROM chips that are programmed with the appropriate 1 or 0 information prior to insertion onto the PMM assembly.

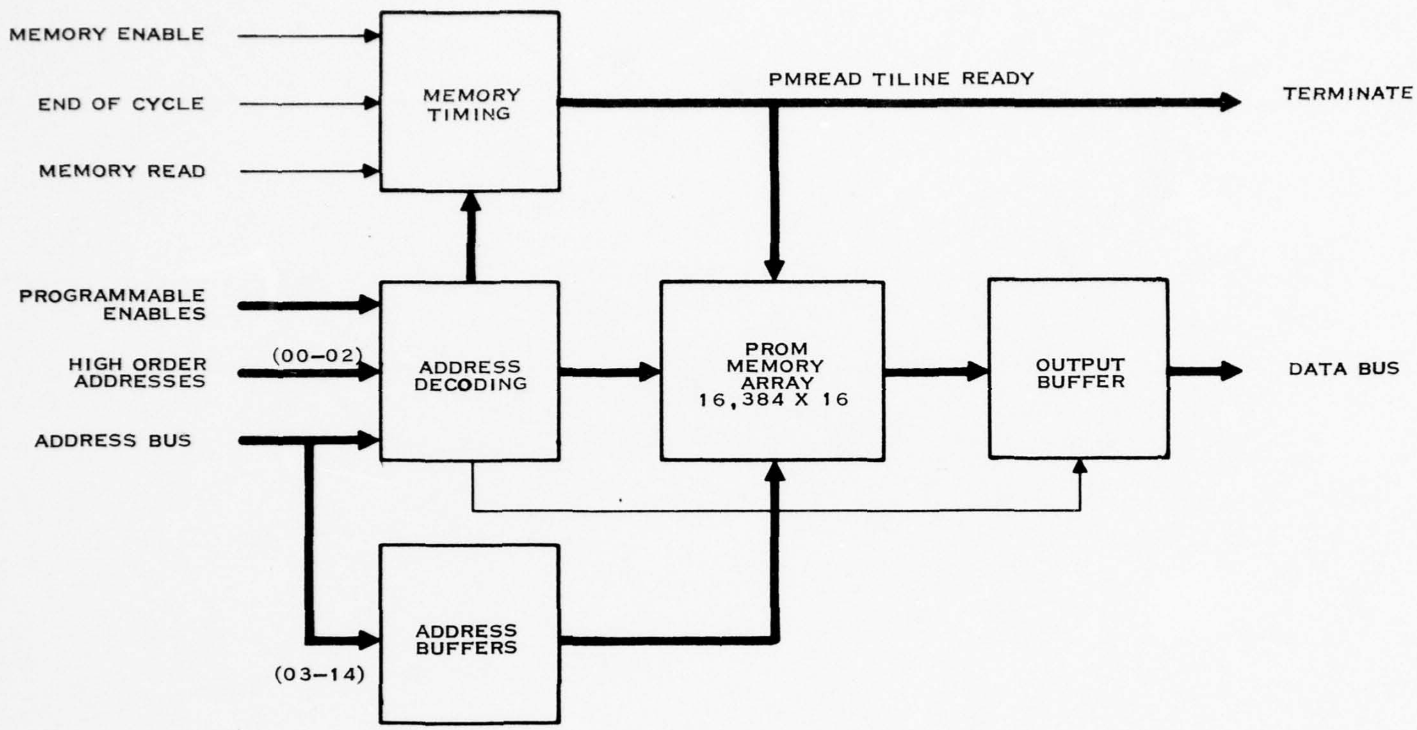

Figure 6.2.4-1. Program Memory Module Functional Block Diagram

The Memory Array is controlled by the buffered address bus and by the various enables generated by the Address Decoding and Memory Timing sections.

The Output Buffer section buffers the data read from the Memory array onto the system bus when enabled by the Address Decoding section. Key interface commands (PM READ, Interface Terminate, Ready) are buffered to allow proper interfacing with external modules.

6.2.4.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
Logic	TLAD (00-14)	System Address initilzed to address within a 32K boundary	MPM
Logic	SEC SEL (0-4)	Memory Sector Select are programmable inputs to define which 32K boundary a module is to occupy.	System Select
Logic	TLDAT (00-15)	Data Bus Bits (16)	MPM
Logic	MEMEN	Memory Enable, Indicate that memory operations is in progress.	MPM
Logic	READ	Defines a Read operation when a memory function is in progress.	MPM
Logic	UPSEOC	Enable Data on to output data bus. Signal is usually active during end cycle of memory operation.	MPM
Logic	SECADR (0-4)	Sector Address signals to allow addressing above the 32K boundary point.	System
Logic	SEL(0-7)	Select signals which allow user to define where within a 32K boundary a particular module will reside.	System

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTINATION
Logic	READY	Indicates that the addressed memory is Ready to be read from.	MPM
Logic	TLTM	Terminate (TM) denotes when the memory device has completed a read or write operation.	System
Logic	PMREAD	Indicates to the system that a READ operation is in progress.	System

6.3 INTERFACE SECTION

6.3.1 EXTERNAL INPUT/OUTPUT MODULE

6.3.1.1 GENERAL DESCRIPTION

The External Input/Output Module (EIOM) performs several of the unique functions required for the correct operation of the MVUE. It provides the interface between the MVUE processor and external devices such as the Control Display Unit (CDU), a AN/PRC-25/77 Radio Set, and another MVUE (For the direct handover capability). It generates all the system clocks, timemarks and interrrupts required by the Receiver/Processor unit. The EIOM controls the power supply and the MVUE'S different power modes of operation: OFF, STANDBY/WARMSTART, and ON. It also provides a memory paging capability for the processor. And, it can accurately measure short periods of time, a necessity while the MVUE is in the Standby mode.

6.3.1.2 FUNCTIONAL DESCRIPTION

As seen in the functional block diagram of figure 6.3.1-1, the EIOM is subdivided into several interface areas: Master Oscillator, Receiver, CRU, CDU, Radio, and DHO.

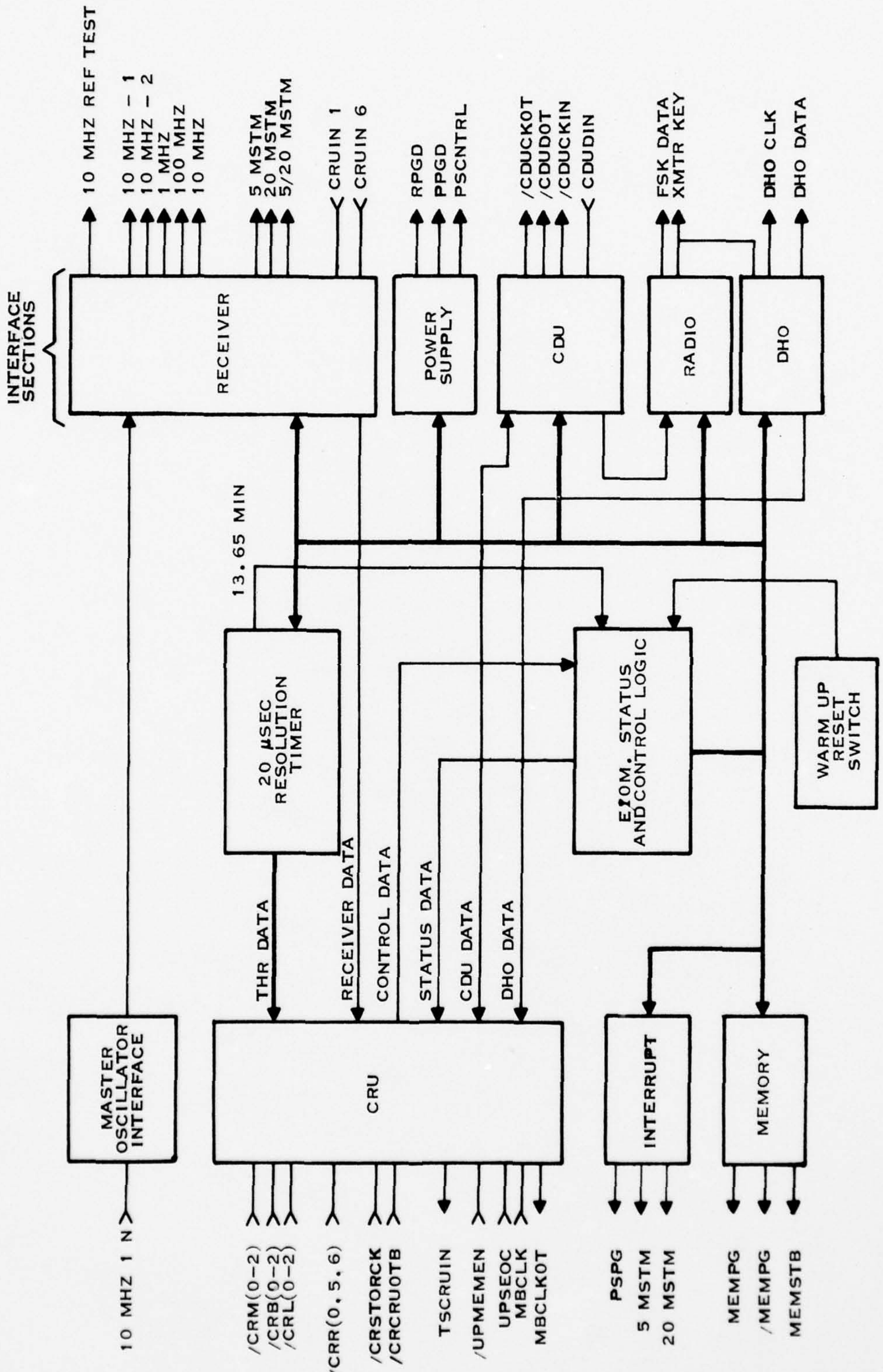

Figure 6.3.1-1. EIOM Functional Block Diagram

I. Master Oscillator

The Master Oscillator interface conditions the 10 Mhz. sinewave from the Master Oscillator. The signal is buffered and converted to a TTL level to drive the clock generation circuits in the receiver interface (And is a time reference source for the standby timer).

II. Receiver

The Receiver interface generates all the timing signals required by the receiver modules. Included in these are the 10 Mhz, 1 Mhz and 10Khz clock signals.

III. Communication Register Unit

The CRU interface consists of the CRU Address Bus and Serial Data Bus, and various processor control and timing signals. This interface is required to allow the processor to interrogate and control the status of the EIOM functions and allow communication to external devices (Such as the CDU).

IV. Standby Timer

The Standby timer is used to count 13.65 minutes while the MVUE is waiting for its Master Oscillator to warm up. At the end of 13.65 minutes, the timer will enable the power supply control signal which turns ON the power supply providing that the CDU ON/STANDBY

switch is ON. The timer is also used to measure the length of time the system is in Standby mode. The timer output can be read by the processor through the CRU Interface.

V. Input/Output

The CDU, Radio and DHO interfaces provide the correct electrical characteristics and functions allowing the MVUE processor to serially communicate to each of these devices.

VI. Status

The EIOM status and Control latches control the operational states of each function in the EIOM. A control latch, for example, will allow serial data from the MVUE processor to be sent to the CDU via the CRU and CDU interfaces in the EIOM.

VII. Memory

The memory interface will page different blocks of memory for the processor, providing the correct control latches are set. The interface also protects memory during Standby mode.

VIII. Power Supply

The power supply interface controls which mode the power supply is in. It also monitors power supply status signals from it and allows the processor to interrogate them.

6.3.1.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTICS	
Rf	10 Mhz in	10 Mhz sinewave	Master Oscilator
logic	/CRR(1,5,6)	CRU decoded adress bits	Crim
data	/CRM(0-3)	CRU module address bits	Crim
data	/CRB(0-3)	Cru byte address bits	Crim
data	CRL(0-3)	Cru latch address bits	Crim
logic	/UPMEMEN	Valid memory address	MPM
logic	UPSEOC	End-of-cycle	MPM
logic	MBCLK	Microprocessor clock	MPM
logic	PPGD	Primary power good	Power supply
logic	RPGD	Regulated power good	Power supply
logic	CRUIN1	CRU data line	MPM
logic	CRUIN6	CRU data line	BITE
logic	/CDUDOT	CDU serial data out	CDU
logic	/CDUCKOT	CDU serial data clock	

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTICS	DESTINATION
Rf	10 Mhz-1	10 Mhz square wave	Receiver
Rf	10 Mhz-2	10 Mhz square wave	Receiver
logic	MEMSTB	Memory standby protect	DMM
logic	10 Mhz REF	10 Mhz status flag	BITE
logic	1 Mhz	1 Mhz square wave	Receiver
logic	100 Khz	100 Khz square wave	Receiver
logic	10 Khz	10 Khz square wave	Receiver
logic	5/20 MSTM	5/20 msec time mark	Receiver
logic	/CDUDIN	CDU serial data in	CDU
logic	/CDUCKIN	CDU serial clock	CDU
logic	DHO DATA	DHO serial data	DHO port
logic	DHO clock	DHO data clock	DHO port
logic	XMTR KEY	Transmitter Key	Radio port
audio	FSK DATA	Modulated data from cdu	Radio port
logic	TSCRUIN	CRU serial data out	MPM
logic	MBCKOT	Buffered MPM clock	MISIM
logic	PSPG	Zero level reset	CRIM
logic	5MSTM	5 msec interrupt	CRIM
logic	20MSTM	20 msec interrupt	CRIM
logic	MEMPG	Memory page	DMM
logic	/MEMPG	Memory page inverted	DMM
logic	PSCNTRL	Power supply control	power supply

6.3.2 MVUE POWER SUPPLY MODULE

6.3.2.1 GENERAL DESCRIPTION

The MVUE Power Supply Module (PWR SUP) is intended to convert 24 VDC primary power from either a battery or a 24 volt DC generator to eight (8) regulated DC levels. These levels are outputted to the system on either continuous or switched busses. Thus the user system, by inputting the appropriate command, is capable of setting the power supply into either a full power or minimal power mode. The implementation includes input reverse polarity protection, output current limiting protection, lower input cutoff protection, and over and under output voltage monitoring. The PWR SUP also generates key initialization signals to the user system when power is applied to the unit from a cold start.

6.3.2.2 FUNCTIONAL DESCRIPTION

The PWR SUP functional block diagram is shown in Figure 6.3.2-1. As shown in the figure all 8 power levels are derived from six regulator sections. The levels that are derived from these sections include +5.2 volts, + and - 5 volts, + and -12 volts, + and -16 volts, and +1.5 volts. The 1.5, 5.2, 5.0, and -5.0 levels are derived directly from the input with a switching regulator.

AD-A076 484 TEXAS INSTRUMENTS INC DALLAS EQUIPMENT GROUP F/G 17/7
GLOBAL POSITIONING SYSTEM (GPS). MANPACK/VEHICULAR USER EQUIPME--ETC(U)
AUG 79 F04701-75-C-0181
UNCLASSIFIED SAMSO-SD-TR-79-13-VOL-3 NL

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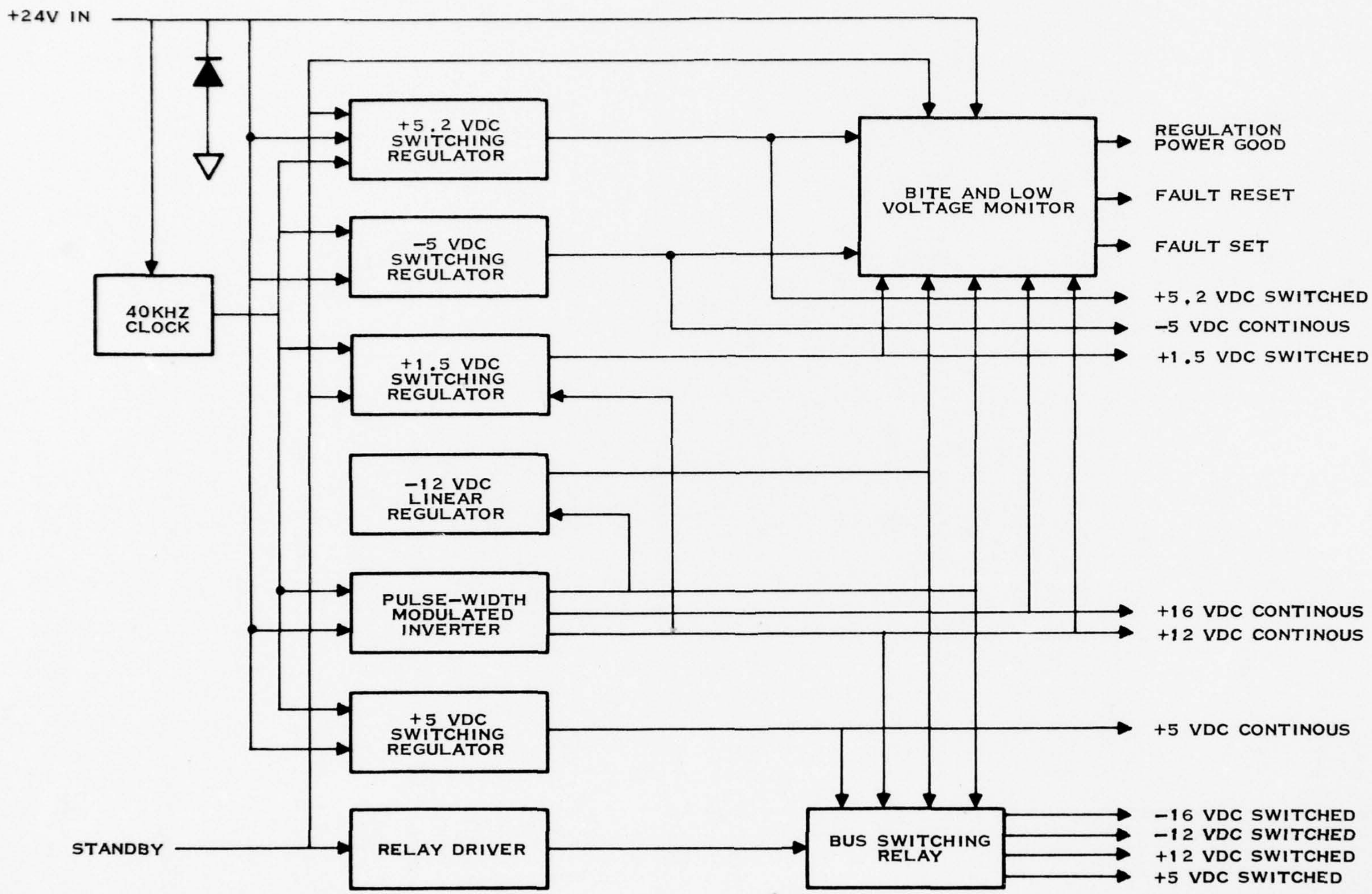


Figure 6.3.2-1. Power Supply Functional Block Diagram

The + and -16 and the +12 volt levels are derived from the Pulse-Width Modulator Invertor. The -12 volt level is then generated from the -16 volt level in a linear regulator.

All voltage levels are routed to te BITE and LOW Voltage Monitor. Each level is monitored for an under and or over voltage condition. The monitor circuitry generates a Fault Set signal when this condition arises for system disposition. When powering up, this section generates a REGULATION good status signal which is utilized by the user system as an initialization command. This signal denotes that all power from the power supply is within tolerable limits.

The BUS SWITCHING RELAY enables the user system to switch the + and - 12 volt, -16 volt and the +5 volt switched bus when the STANDBY input command is activated. The 5.2 volt and the 1.5 volt levels are switched electronically upon receiving the input command. All regulators in the system are driven with a 40 KHz clock. Table 6.3.2-1 is provided to show the current and regulation specifications of each bus generated by the PWR SUP.

The power supply implementation is equipped with an electronic inhibit which is responsive to input voltage level. This inhibit is invoked at a voltage level of 19.0 volts (nominal). When invoked, all power supply functions cease, implying that all busses are off.

TABLE 6.3.2-1. VOLTAGE REGULATION SPECIFICATIONS

	UNIT	+1.5	5.2	5.0	-5	+12	-12	15	-15
Regulation	%	± 4.0	± 5.0	± 5.0	± 5.0	± 5.0	± 5.0	± 5.0	± 5.0
Ripple	MV P-P	50	50	100	50	100	50	50	50
Max Current	MA	1000	1500	11000	500	1500	500	200	200
STDBY Current	MA	0	300	1500	60	500	0	30	0

6.3.2.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
Power	24VDC	DC input minimum 20 volts maximum 30 volts Ripple frequency 100-500Hz RMS RIPPLE 1.0V	Military Battery or DC Generator
Logic	PSINH	TTL Power Supply Inhibit. Signal which controls the switched busses from the unit.	EIOM

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTINATION
Power	Busses	Refer to Table	System
Logic	RPGD	TTL Regulated Power Good. Denotes when all voltage levels are within tolerable limits after a power up and serves to initiate the system	System Processor
Logic	PPGD	TTL Primary Power Good. Test point monitor point which denotes that the input voltage to the power supply is at a proper level.	EIOM
Logic	PWFLT	TTL Power Fault Signal denotes that output voltage are out of tolerance.	System

6.3.3 MVUE INSTRUMENTATION SYSTEM INTERFACE MODULE

6.3.3.1 GENERAL DESCRIPTION

The MVUE Instrumentation System Interface Module (MISIM) is designed to provide a means to monitor key internal system parameters and to buffer interface signals for the Maintenance Panel, DHO, and CDU functions. Via external system addressing, various analog test monitors can be selected for monitor on a real time basis or digitized for storage in some digital storage media. The MISIM provides buffering of signals for the CDU and Maintenance Panel Interfaces. The DHO signals are both buffered and decoded to generate key interface commands.

6.3.3.2 FUNCTIONAL DESCRIPTION

As shown in Figure 6.3.3-1 the MISIM is subdivided into two major sections. The sections include the Test Point Monitor Section and the Interface Buffering Section. The Test Point Monitor accepts analog test point monitor signals from the Receiver/Processor system. They are forwarded to the Analog Multiplexer section. An External Address Bus can be inputted to the module to allow selection of one test point monitor via the External Address Decoding section by loading the address with the Address Strobe command.

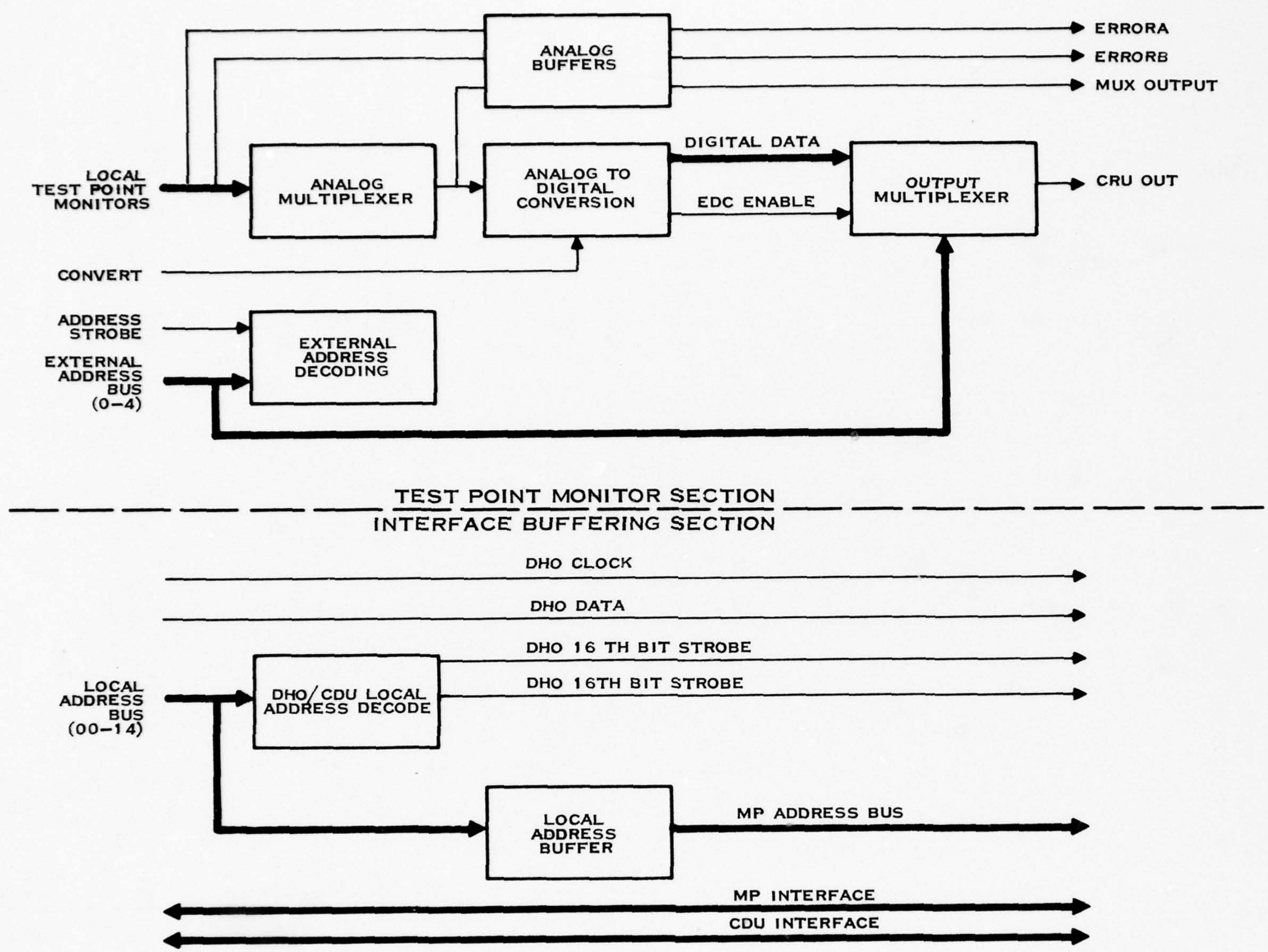


Figure 6.3.3-1. MVUE Instrumentation System Interface Module

Once the address is loaded the user system initiates the conversion cycle by activating the Convert command. After a period of 20 microseconds the conversion results (digital data) is read via the Output Multiplexer by again utilizing the External Address Bus to serialize the data onto the CRU OUT signal. Certain important signals are buffered off the module for real time monitoring via the Analog Buffer section. The signals include ERROR A, ERROR B, and MUX OUTPUT. A user after having selected a specific monitor signal may also monitor the signal on the MUX Output signal on a real time bases. The signals that are available for conversion are shown on the I/O section of this description. The Interface Buffer Section breaks into three major areas. The first in the Direct Hand over (DHO) area. The module routes the DHO clock and data signals directly through the board. The Local Address Bus (00-14) is decoded to generate a 16th bit Strobe for the DHO function. This strobe is generated when the 16th bit of a DHO serial transfer is present on the DHO Data signal. This strobe may be used by any user system to denote that data is available. When 16 bits of data are transfered, 16 bit clock pulse are generated on the DHO clock signal. The second area is the Maintenance Panel (MP) Interface. This area consists of buffering for the Local Address Bus, and other MP Interface signals are mearly routed thru the module. The third area is the Control Display Unit (CDU) Interface which again merely consists of signals being

routed through the module.

6.3.3.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
Monitor	5V+	Power Supply 5 volt continous bus test point	PWR SUP
Monitor	-5V+	Power Supply -5 volt continous bus test point	PWR SUP
Monitor	12V+	Power Supply 12 volt continous bus test point	PWR SUP
Monitor	-12V+	Power Supply -12 volt continous bus test point	PWR SUP
Monitor	15V+	Power Supply 15 volt continous bus test point	PWR SUP
Monitor	-15V	Power Supply -15 volt switchable bus test point	PWR SUP
Monitor	5.2V	Power Supply 5.2 volt switchable bus test point	PWR SUP
Monitor	1.5V	Power Supply 1.5 volt switchable bus test point	PWR SUP
Monitor	1st AGC	Analog Signal. Automatic Gain Control test point from the wideboard module. Varies between 0 and 10 VDC. This signal is from the first AGC stage in the receiver	WBM
Monitor	AGC2A and AGC2B	Analog signal. Automatic Gain Control test point from the narrowband module. Varies between 0 and 5VDC This signal are from the second AGC stage.	NBM
Monitor	MUX DATA	Analog signal. 50 Hz NRZ detected data from SV signal.	OM
Monitor	MUX COR1 and	Analog Signal. Correlation signal that represent the	OM

	MUX COR2	degree of correlation between the local code and the receiver code. Varies between 0 and 10 VDC.	
Monitor	VCOIN	Analog Signal that represent input to VCXO in Frequency Synthesizer module. Varies between 15 VDC and -15 VDC	FSM
Monitor	LOOP IN	Analog Signal that represents, the Error signal (frequency or phase) associated with the Costas Loop being inputted to the Synthesizer VCXO. Varies between 12 VDC and -12 VDC	FSM
Monitor	ERROR A and ERROR B	Analog Signal that represents the detected error from the Costus Loop. This signal represents position error	FSM
Monitor	10 MHz	RF 10 MHz frequency reference	EIOM
Monitor	MEMPG	TTL Memory paging status signal	EIOM
Monitor	XIAGO	TTL XI code start command from BITM	EIOM
Monitor	C/A EPOCH	TTL 1MS repeating signal which is in sync with incoming signal C/A code	CGM
Monitor	DATA CLOCK	TTL 50 Hz clock pulses which are in sync with incoming signal	CGM
Monitor	MBCLKOT	TTL Processor clock. Frequency is 2.75 MHz	MPM
Monitor	P4	20.23 MHz RF signal	FSM
Logic	MPCRUINZ	Maintenance panel (M/P) serial input data	MPM
Logic	MPLOADZ	Non-maskable interrupt to M/P load routine	MPM
Logic	UPIAGZ	M/P instruction fetch	MPM

Logic	UPENDCYZ	M/P end-of-cycle	MPM
Logic	UPRSTZ	M/P reset	MPM
Logic	UPVCCSAM	15V status	MPM
Logic	UPCLK	Clock output source	MPM
Logic	UP8.25 Hz	Cycle clock output	MPM
Logic	UPBDBIN	Output buffer disable	MPM
Logic	UPCRUOUT	CRU Serial data output	MPM
Logic	UPCRUCLK	CRU data clock	MPM
Data Logic	UPA (00-14)E	Memory Address Bus	MPM
Logic	CDUCKIN	Control Display Unit Clock in (TTL)	EIOM
Logic	CDUDIN	Control Display Unit Data In (TTL)	EIOM
Logic	CDUDOT	Control Display Unit Out (TTL)	EIOM
Logic	CDUCKOT	Control Display Unit Clock Out (TTL)	EIOM
Logic	DHO DATA	Direct Handover Serial Data	EIOM
Logic	DHO CLK	Direct Handover Clock	EIOM
Monitor	5ms	5ms Time Marks	EIOM
Monitor	20 ms	20 ms Time Marks	EIOM
Data	ADDR (10-14)	User External Address Bus	User System
Logic	A/D START	Analog to Digital conversion start command	User System
Logic	A/D ADDR LATCH STROBE	Analog to Digital conversion address strobe	User System
Logic	A/D MUX ENABLE	Analog Multiplexes Enable command	User System

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTINATION
Logic	MPCRUINZ	Maintenance panel (M/P) serial input data	MPM
Logic	MPLOADZ	Non-maskable interrupt to M/P load routine	MPM
Logic	UPIAQZ	M/P instruction fetch	MPM
Logic	UPENDCYZ	M/P end-of-cycle	MPM
Logic	UPRSTZ	M/P reset	MPM
Logic	UPVCCSAM	15V status	MPM
Logic	UPCLK	Clock output source	MPM
Logic	UP8.25 mh	Cycle clock output	MPM
Logic	UPBDBIN	Output buffer disable	MPM
Logic	UPCRUOUT	CRU Serial data output	MPM
Logic	UPCRUCLK	CRU data clock	MPM
Data	UPA (00-14)Z	Memory Address Bus	MPM
Logic	CDUCKI11	Control Display Unit Clock in (TTL)	EIOM
Logic	CDUDIN	Control Display Unit Data In (TTL)	EIOM
Logic	CDUDOT	Control Display Unit Out (TTL)	EIOM
Logic	CDUCKOT	Control Display Unit Clock Out (TTL)	EIOM
Logic	DHO DATA	Direct Handover Serial Data	EIOM
Logic	DHO CLK	Direct Handover Clock	EIOM

Logic	DHO 16th Bit Strobe	TTL Direct Handover denoting 16th bit transmitted on DHO data line	User System
Logic	CDU 16th Bit	TTL Control Display Unit strobe denoting 16th bit transmitted on CDU data line	User System
Monitor	5ms	5ms time marks	User System
Monitor	20ms	20ms time marks	User System
Monitor	ErrorA and ErrorB	Analog signal that represents the detected error from the costus loop. This signal represents position error.	User System
Monitor	XIAGO	TTL XI code start command from BITM	User System
Monitor	TPMNX	Analog Output of test point monitor multiplexer	User System
Monitor	10MHz	RF 10 MHz frequency reference	User System
Logic	A/D EOC ENABLE	Analog to Digital Conversion End of Cycle	User System

6.3.4 MEMORY BUFFER BOARD

6.3.4.1 GENERAL DESCRIPTION

The Memory Buffer Board is essentially a buffering board utilized with a RAM Receiver/Processor only which provides additional drive capability for the system processor, when addressing certain sections of memory. The unit is equiped to decode when the address bus is addressing the special areas of memory such that the buffers (Tri-state) can be activated.

6.3.4.2 FUNCTIONAL DESCRIPTION

As shown in Figure 6.3.4-1 the Memory Buffer Board is broken down in to three areas. The Tri-State Buffers accept Data Bus information from external sources and when enabled by the Address Decode area, drive the information to its destination. The Address Decode Area enables the Tri-State Buffers only when address between 8193 and 24,576 are being accessed. The specific set of drivers that are enabled is determined by whether a read or write operation is in progress which is defined by the DATA BUS IN signal. The Address Buffers area merely provides additional drive for the Address Bus to user destinations.

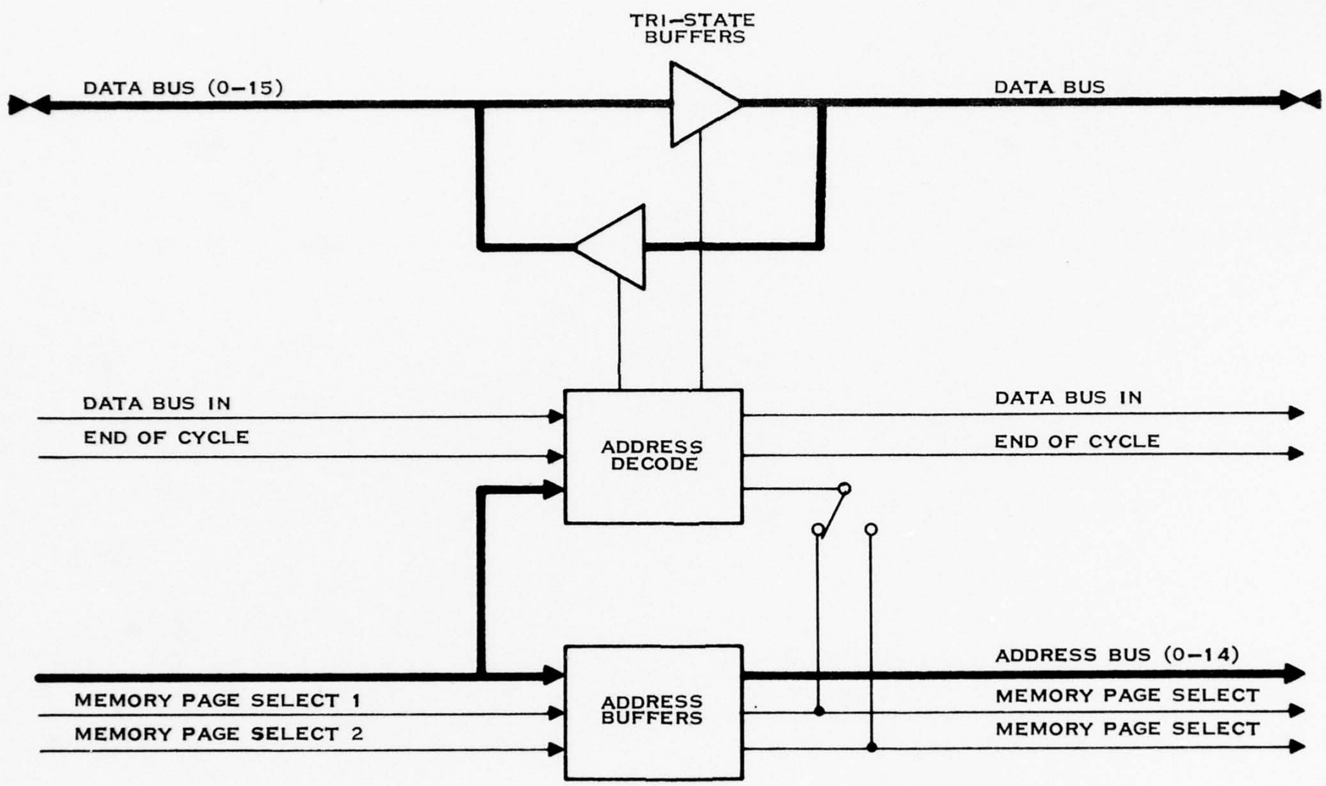


Figure 6.3.4-1. Memory Buffer Board Functional Block Diagram

Two additional signals which are buffered are the Memory Page Select 1 and 2. Either one of the two outputs from the buffers may be selected to be an enable in the address decode function. Thus, depending on which page is desired the Tri-State Buffers may or may not be enabled.

ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
Input/ Output	TSD (00-15)	TTL Tri-State Processor Data Bus	MPM/System Memory
Logic	OCPAREN	TTL Parity Enable indicates that parity needs to be checked or generated on the Parity Data Line	MPM
Logic	MEMPG and/ MEMPG	TTL Memory Paging Enable.	EIOM
Logic	MPDBIN	TTL Data Bus In. Defines a read operation when a memory operation is in progress.	MPM
Logic	UPSEOC	TTL End Of Cycle. Enables Data on to output data bus. Signal in action during end cycle of memory operation	MPM
Logic	TSPAR	TTL Parity Data Bit	CRIM
Logic	UPMEMEN	TTL Memory Enable. Indicates that memory operation is in progress.	MPM
Data	UPA (00-14)	TTL Processor Address Bus	Sys Memory

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTINATION
Logic	OCPAREN	TTL Parity Enable indicates that parity needs to be checked or generated on the Parity Data Line	Sys Memory
Logic	MEMPG and/ MEMPG	TTL Memory Paging Enable.	Sys Memory
Logic	MPDBIN	TTL Data Bus In. Defines a read operation when a memory operation is in progress.	Sys Memory
Logic	UPSEOC	TTL End Of Cycle. Enables Data on to output data bus. Signal in action during end cycle of memory operation	Sys Memory
Logic	TSPAR	TTL Parity Data Bit	Sys Memory
Logic	UPMEMEN	TTL Memory Enable. Indicates that memory operation is in progress.	Sys Memory
Data	UPA (00-14)	TTL Processor Address Bus	Sys Memory

6.3.5 BATTERY PACK

6.3.5.1 GENERAL DESCRIPTION

The Battery Pack (BAT PAK) is the source of power for the Manpack configuration. The BAT PAK is capable of acccepting two 24VDC (nominal) batteries (Nicad BB590 or Lithium BA5590). The BAT PAK includes the capability to disconnect its output to the user system when the voltage from the batteries are below a cutoff threshold.

6.3.5.1 FUNCTIONAL DESCRIPTION

As shown in Figure 6.3.5-1 the BAT PAK is composed of a set of batteries (QTY 2) and a voltage monitor section. The batteries can be either Nicads or Lithiums. Each battery is connected to a series diode which prevents charging of the batteries while in the BAT PAK. This protection is particularly important with Lithiums which should not be charged. The voltage monitor section taps off the cathode terminator of the two diodes. The 24 VDC tap is forwarded to the Transient Suppressor which prevents sudden changes in output load from erroneously tripping the Threshold Detector. The output of the Transient Suppressor is routed to the Threshold detector which is designed to activate its output at 19.25 VDC (nominal).

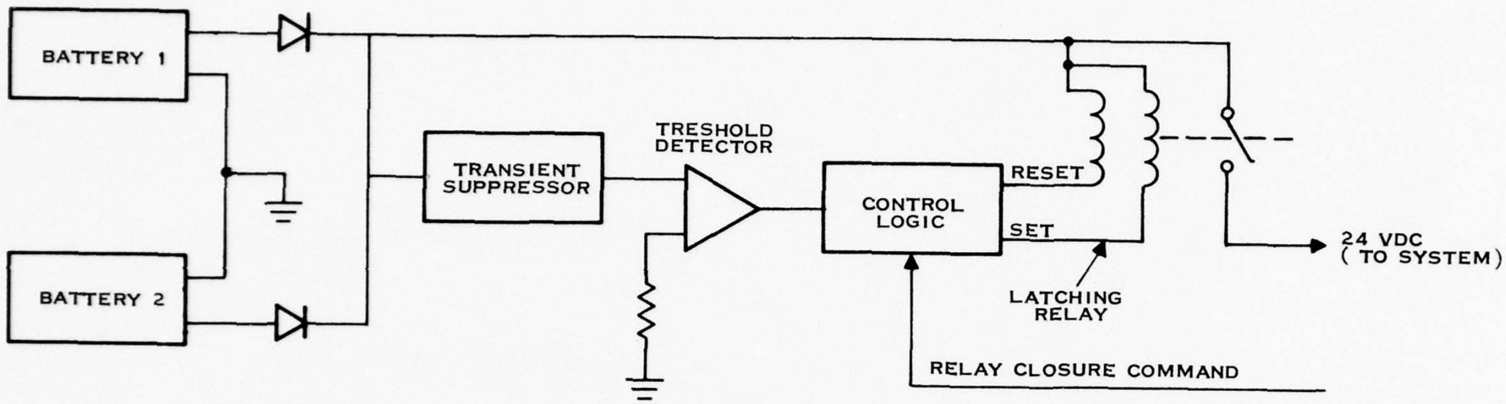


Figure 6.3.5-1. Battery Pack Functional Block Diagram

When this threshold is exceeded the Control Logic section generates a RESET pulse which forces the Latching Relay to the open switch state. When the switch is opened, the output 24 VDC signal is disconnected from the batteries. To close the relay for enabling 24 volts to the output, the Relay Closure Command must be cycled. Cycling the closure command generates a SET pulse to the Latching Relay which closes the switch.

6.3.5.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY TYPE	SIGNAL NAME	CHARACTERISTIC	SOURCE
Logic	TTL CNTRL	Relay closure command to enable 24 VDC to BAT PAK output RF sources. RF sources.	User System

II. Outputs

CATEGORY	SIGNAL NAME	CHARACTERISTIC	DESTINATION
PWR	24 VDC	24 volts DC from batteries 2.5 AMP (nominal)	User System

6.3.6 CONTROL DISPLAY UNIT

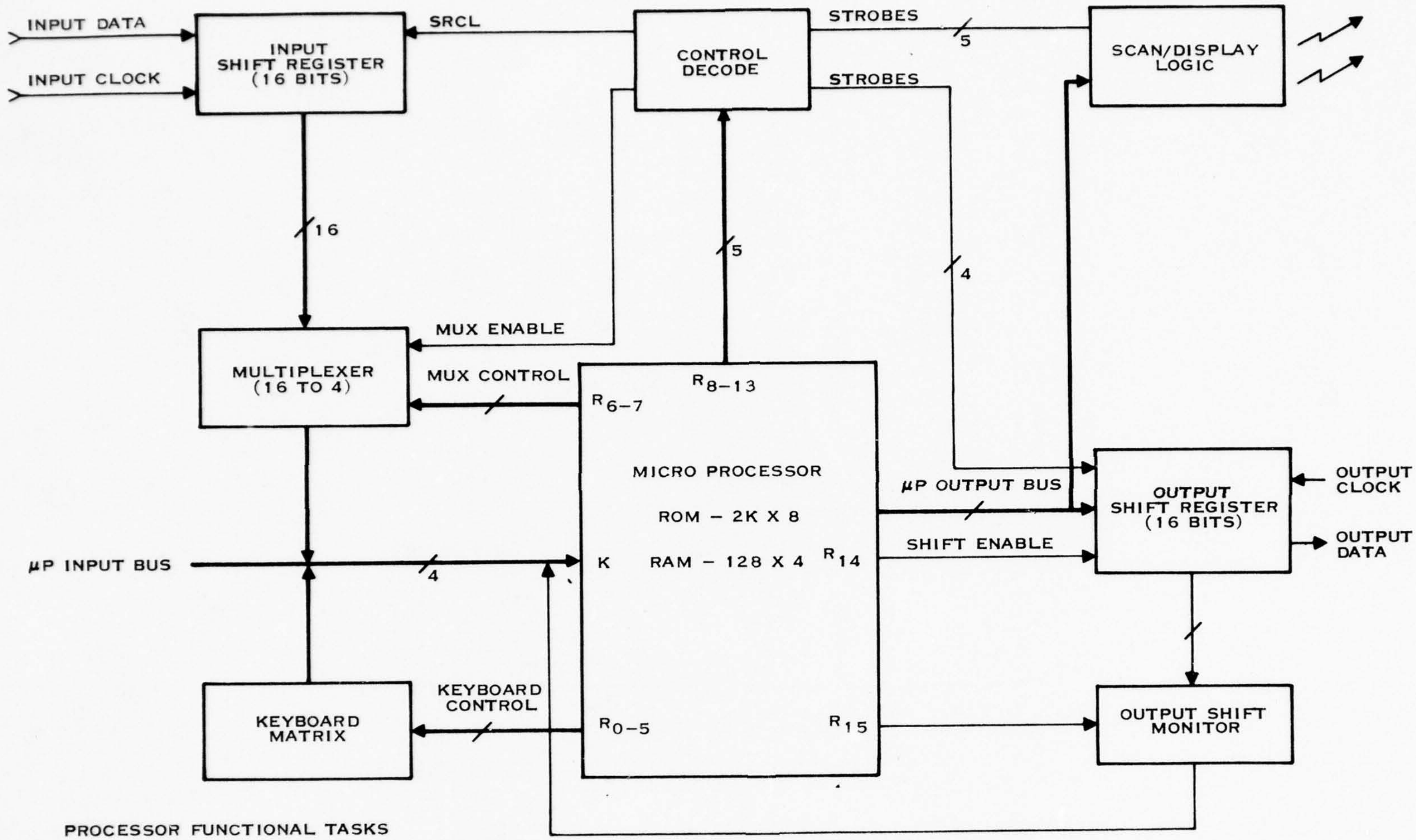
6.3.6.1 GENERAL DESCRIPTION

The Control Display Unit (CDU) is a handheld input/output device. This unit provides system communication to the user/operator. It allows the user to control the MVUE system and/or display pertinent system information. The CDU is used with the MVUE to communicate with a AN/PRC-25/77 Radio Set or a Digital Message Device (DMD).

6.3.6.2 FUNCTIONAL DESCRIPTION

The functional block diagram of the CDU is shown in figure 6.3.6-1. It consists of an input buffer, an output buffer, a microprocessor, a matrix keyboard, scan and display logic, a multiplexer, and control decode logic.

The input shift register is used as an intermediate storage register that accepts a 16-bit data word serially from the MVUE processor via the EIOM. Under microprocessor control, the multiplexer is used to read the input data in 4-bit nibles. The input data is decoded by the processor, which inturn sends the correct display or control information to the scan/display logic. This information is then displayed on the alpha-numeric display/readout.



PROCESSOR FUNCTIONAL TASKS

A. KEYBOARD INTERFACE

B. DISPLAY CONTROL

C. PROCESSOR INTERFACE

Figure 6.3.6-1. CDU Functional Block Diagram

The microprocessor is constantly scanning the keyboard matrix. When a key is pressed and sensed by the microprocessor, a keycode is stored in the Output shift register. This register is polled by the MVUE via the EIOM, and is read when a keycode has been stored in it.

A special function of the CDU is to correctly format the information normally displayed on the alpha-numeric displays to a format acceptable to a Digital Message Device. All the characters displayed are re-formatted. The data is then stored in the output shift register. The data is serially shifted out and Frequency-Shift Modulated via the EIOM. The modulated data then can go to a DMD or a AN/PRC-25/77 Radio Set.

6.3.6.3 ELECTRICAL INTERFACE

I. Inputs

CATEGORY	SIGNAL NAME	CHARACTERISTICS	SOURCE
Power	5VDC	Continuous 5v power	P/S
Power	-12VDC	Continuous -12v power	P/S
Logic	/CDUDIN	Serial data input line	EIOM
Logic	/CDUCKIN	Data clock	EIOM

II OUTPUTS

CATEGORY	SIGNAL NAME	CHARACTERISTICS	DESTINATION
Logic	/CDUDOT	Serial data output line	EIOM
Logic	/CDUCKOT	Output data clock	EIOM

APPENDIX A

MVUE USER'S MANUAL

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LIST OF TABLES

1. SCOPE

This manual describes the use and operation of the Manpack Vehicular User Equipment (MVUE) and its configuration when used with the MVUE Instrumentation System (MIS).

2. HARDWARE DESCRIPTION

Figure 1 shows the MVUE equipment layout.

2.1 Receiver/Processor Unit

The Receiver/Processor consists of a single channel GPS receiver and a 9900 microprocessor-based data processing unit. The memory consists of two 16K pages which can be selected by the processor, plus root memory making a total of 47,360 16-bit words.

2.2 Control Display Unit

The Control Display Unit (CDU) provides operator interface to the receiver/processor unit. The CDU displays prompting messages, system status and navigational data to the operator. The keyboard allows the operator to initiate commands and input necessary data to the system.

2.3 Vehicle Installation Kit

The vehicle installation kit consists of the vehicle antenna mount, a power filter unit, a shock mount tray and four cable assemblies. This allows the antenna to be mounted separately from the MVUE.

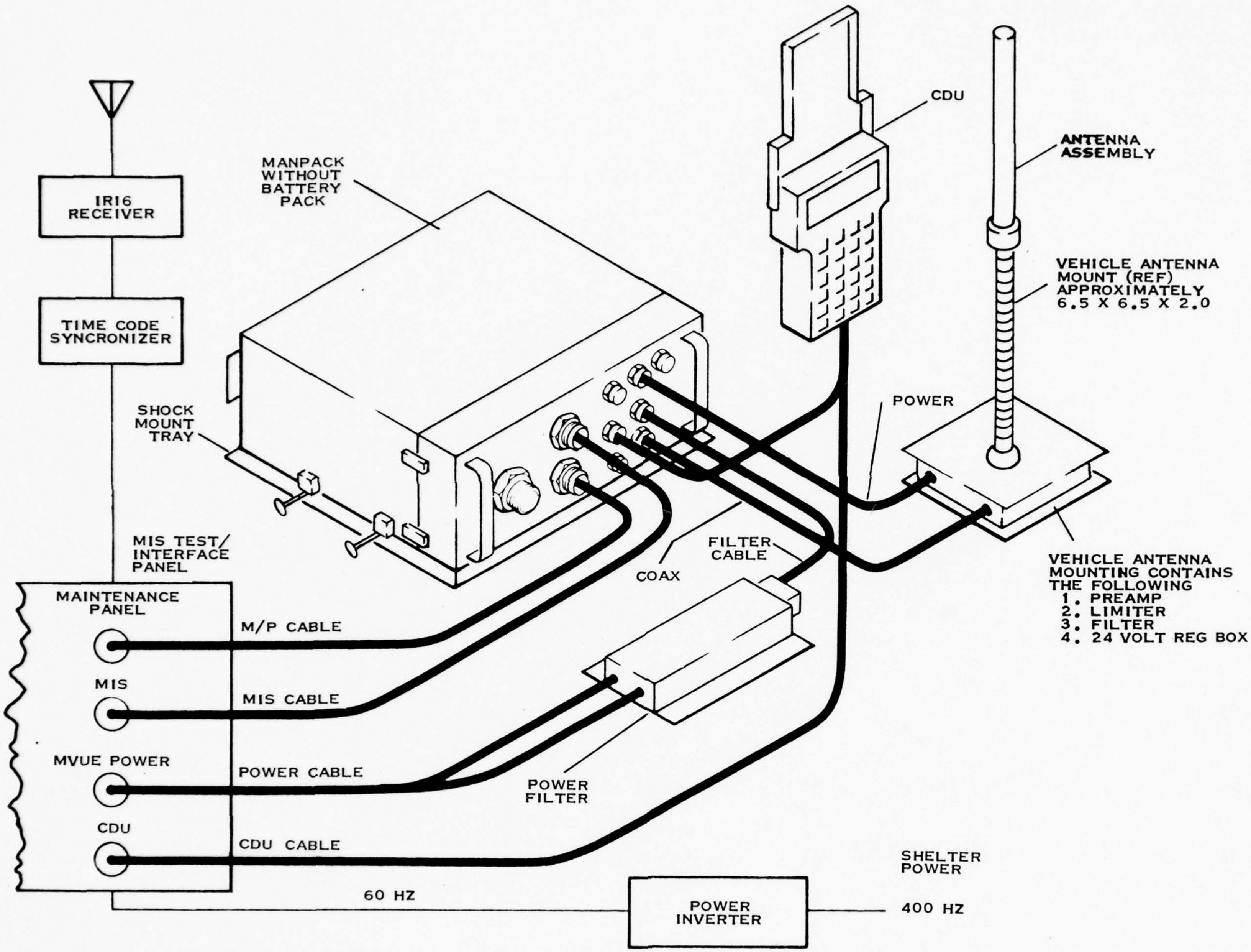


Figure 1. Overall Vehicle Installation

2.4 Antenna

The antenna unit can be mounted directly to the MVUE Receiver/ Processor Unit or with the Vehicle Installation Kit (VIK).

2.5 Manpack Instrumentation System (MIS)

The MIS is used to record analog data in the MVUE GPS Receiver, all CDU transactions and software data sets transmitted through the direct handover port (DHO). This data is time tagged and recorded on magnetic tape using UFTIN format. The MIS is also used to download software into the MVUE and directly control its activity. CDU commands to the MVUE can be entered by the MIS to perform repetitive operations and eliminate any operator errors.

3. HARDWARE SETUP AND INITIALIZATION

3.1 Setup

The MVUE and MIS systems need to be connected as shown in Figure 1. Make sure power is OFF on all equipment. Notice that three (3) cables go to the MIS from the MVUE.

3.2 Initialization

3.2.1 MIS Initialization

3.2.1.1 Check that power is ON to the DISC DRIVE and that the LOAD/ RUN switch is in the LOAD position.

3.2.1.2 Turn power ON to the 990/10 chassis. Use the key and turn to the UNLOCK position.

3.2.1.3 Turn power ON to the maintenance panel.

3.2.1.4 Press HALT button on the 990/10 front panel.

3.2.1.5 Press RESET button on the 990/10 front panel.

3.2.1.6 Note that the FAULT, IDLE and RUN LEDs are OFF on the 990/10 front panel.

3.2.1.7 Move the LOAD/RUN switch on the DISC DRIVE to the RUN position.

3.2.1.8 On the DISC DRIVE, wait until the YELLOW light comes On, then press the RED button.

3.2.1.9 Press the LOAD button on the 990/10 front panel.

3.2.1.10 Note that the log on the ASR 733 will print INITIALIZATION COMPLETE.

3.2.2 MVUE Initialization

The MVUE can be initialized two (2) ways. During normal operating conditions, the MVUE requires a 13.5 minute warm-up period before acquiring satellites.

This feature can be over-ridden if the operator does not intend to ask for navigational information or position within this time. Follow either initialization procedure in paragraph 3.2.2.1 or 3.2.2.2.

3.2.2.1 13.5-Minute Warm-up Initialization

3.2.2.1.1 Turn the MVUE POWER switch to the EXT position (See Figure 2).

3.2.2.1.2 Turn the CDU switch to the ON position (See Figure 3).

3.2.2.1.3 Allow approximately 13.5 minutes for the MVUE to warm-up.

3.2.2.2 Warm-up Over-ride Initialization.

3.2.2.2.1 Turn the MVUE POWER switch to the EXT position (See Figure 2).

3.2.2.2.2 Depress the WARMUP OVERRIDE button on the top of the MVUE.

3.2.2.2.3 Turn the CDU switch to ON (See Figure 3).

3.2.3 MVUE Software Loading Initialization

3.2.3.1 Verify current MVUE link is named .MVLINK on the system Diablo DISC.

3.2.3.2 Verify the batch control file for downloading the MVUE link is named .BATCH on the system Diablo DISC. The batch control file contains the commands to initialize memory to >0340's, load the current MVUE link, reset the processor, and start execution. The commands in the batch control file are listed in Table 1.

3.2.3.3 Hit ! on the log.

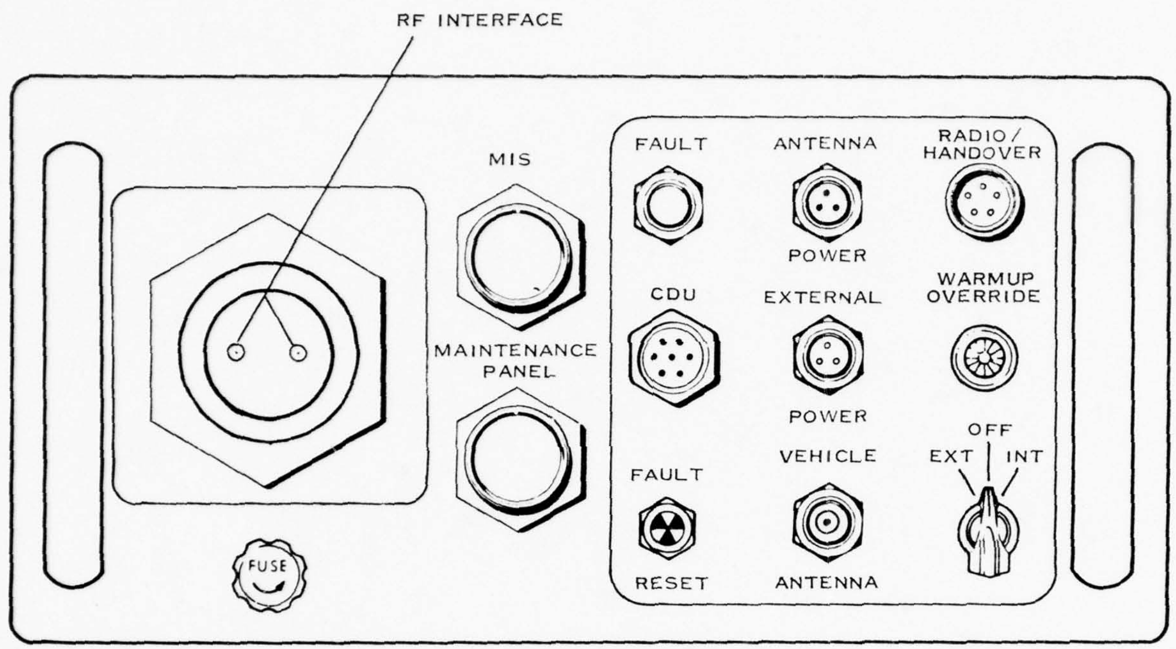


Figure 2. MVUE Top View

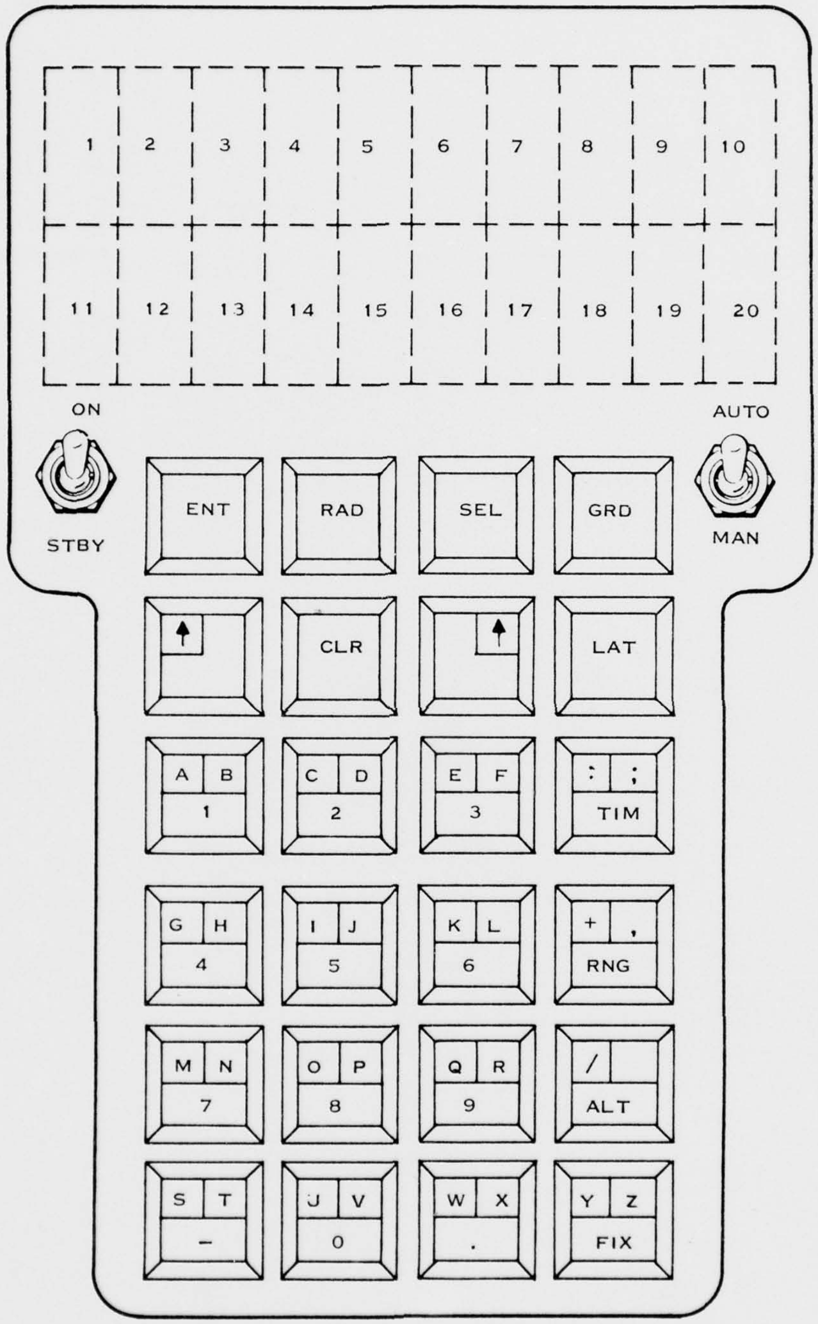


Figure 3. MVUE CDU Keyboard/Display Layout

TABLE I

TCP LOAD FILE

```
TI
CP
1
SP
1
GP
1
LP
.MLOADO
ØØØØ
DUMY
N
MR
ØØØE
ØØØØ
ØØØØ
EX
PS
PS
HP
LP
.MLOADO
ØØØØ
DUMY
N
GP
2
MR
ØØØE
ØØØØ
ØØØØ
EX
PS
PS
HP
GP
1
LP
.MVLINK


Y
GP
1
RS
EX
TI
QU
```

NOTE: Ø = ZERO

3.2.3.4 Enter AL, F1, BATCH. and press RETURN.

3.2.3.5 Enter EX, D1, F1, 1.TE. and press RETURN.

The log will record the TCP commands as the MVUE is downloaded. The process takes several minutes. The operator should note the following statements in the log output. After the operator has initialized time and position he may command the MVUE system to go into the transmitter acquisition mode by depressing the FIX button. The CDU Keyboard will then be locked out by the system until the first fix is displayed. During this time the acquisition status will be displayed every thirty seconds.

1) SUCCESSFUL LOAD FOR .MVLINK PAGE 0
2) SUCCESSFUL LOAD FOR .MVLINK PAGE 1
3) SUCCESSFUL LOAD FOR .MVLINK PAGE 2
4) SUCCESSFUL LOAD FOR .MVLINK
5) the current time, day of the week, and date

The operator may verify the completion of the software loading process and the start of the program execution by a full lights-on display on the CDU for two (2) seconds followed by a flashing 1 display for 10 seconds.

4. INITIALIZATION MODE

* Statement 1, 2, or 3 will be output one time for every software phase in that page.

4.1 Requirements for System Initialization Using the CDU

To initialize the MVUE after power up, the operator must input position and time. Optionally, the operaator may input other parameters such as altitude, the SV constellation and waypoints. He may also request any functions to be performed except for altitude or fix display. Position and time must be input before FIX is depressed. If not, then a flashing I will indicate insufficient initialization. If altitude is not initialized by the operator, mean sea level is used for the initial position.

Time is input in a Julian date and a 24 hour clock Greeenwich time as described in section 4.3.3. The time initialized must be within 4 minutes of true time. The reference point is when the operator depresses the ENTER key to input seconds. Position can be input in either latitude/longitude or in the UTM/MGRS system. Position must be initialized within approximately 25 kilometers of the true position.

4.2 Prompting Scheme for CDU Data Entry

An operator suppplies data to the MVUE by using a general prompting shceme. The scheme consists of two (2) levels of prompting. The major prompting level determines the major class of the data to be supplied. Time and position are examples of major prompting levels. The minor level prompts the user for the specific data values. Year, day, hour, minute, and seconds are examples of minor levels of prompting that an operator may use when supplying data for the major level of

time. An operator uses the prompting scheme by:

1) choosing the correct major level for the type of data to be entered,

2) choosing the specific minor level data item to be supplied, and

3) entering valid data and commanding the MVUE MVUE system to accept the data.

4.2.1 Major Level Prompting

A major level of the MVUE prompting scheme is entered by depressing the (SEL) key followed by a decimal digit. The major level code consists of three (3) letters that appear on the CDU in Displays 1, 2, and 3. The major level codes are defined below:

1) UTM - user position or waypoints expressed in UTM/MGRS,

2) ALT - mean sea level altitude at the user position,

3) TIM - user time defined in the ZULU system (24 hour clock, Julian date),

4) OPT - user options (MIS control, selection of the radio band rate, ephemeris update authorization, user dynamics, SV acquisition, creation of a DMD display),

5) OP2 - user options continued (automatic almanac acquisition, RESTART request, RAM almanac request, ionospheric correction, atmospheric corrections),

6) BIT - built-in-test authorization,

7) SV - satellite constellation selection,

8) MEM - memory read/write,

9) LAT - user position or waypoints expressed in latitude and longitude.

The operator has three (3) choices at a major prompting level:

1) enter (-) to terminate the prompting session,

2) enter (.) to enter the minor prompting level, or

3) enter (SEL) to advance the major level number by one. If the major level is LAT, entering (SEL) cycles the major level to UTM.

4.2.2 Minor Level Prompting

Table II contains the minor prompting levels for each major prompting level.

A minor level of prompting is entered by supplying a (.) while in a major prompting level. Displays 1, 2, and 3 will contain the identifying two or three letter minor level code. The operator has four options after entering a minor level:

TABLE II

CDU PROMPTING MENU

1	UTM		5	OP2	
	.	WPT		.	ALM
	.	SPH		.	RST
	F	GRD		.	RAM
	F	MG		.	ION
	F	ESG		.	ATM
	F	NRG	6	BIT	
				.	NUM
2	ALT		7	SV	
	.	ALT		F	SV1
				F	SV2
3	TIM			F	SV3
	.	OUT		F	SV4
	F	YR		F	SV5
	F	DAY		F	SV6
	F	HR	8	MEM	
	F	MIN		.	ADR
	F	SEC			CNT
4	OPT		9	LAT	
	.	MIS		.	WPT
	.	RAD		.	SPH
	.	EPH		F	DIR
	.	MOV		F	DIR
	.	ACQ		F	DEG
	.	TXT		F	MIN
				F	SEC
				F	DIR
				F	DEG
				F	MIN
				F	SEC

4.2.2 (continued)

1) enter (-) to terminate the prompting session

2) enter (SEL) to return to major level prompting with the major level advanced by one. If the major level is LAT, the major level will be set to UTM.

3) enter (.) to advance the minor level by one. This option allows the operator to select a particular minor level item in a major level. If the (.) occurs at the last item in a major level, the system advances to the next major level of prompting.

4) enter (CLR) to start the data entry process.

When initializing a function such as time, the operator is required to input year, day, hour, minutes, and seconds. These items are members of a logical input set. When the operator completes the data entry process for the first data item of a logical input set, the system advances the minor level by one which is identified by a new code in Displays 1, 2, and 3. Underscores appear and data entry is the only acceptable input. The procedure is repeated for each item of the set, forcing the operator to input all of the remaining data items of the logical input set. The operator is prohibited from entering data starting with items other than the first item of a logical input set. The operator may view the minor level codes, but an attempt to supply data results in a return to the major level of prompting. Data in a logical input set will be called forcing data.

4.2.3 Data Entry Process

The data entry process is initiated by depressing (CLR) while in a minor level of prompting. The appearance of underscores signifies that data entry is expected. The length of the data field is described by the number of underscores in the lower right displays of the CDU. The data is grouped into four types:

1) free text - all alphanumeric and punctuation characters

2) limited alpha - A to Z, less I and $\overline{0}$

3) decimal - 0 to 9

4) hexadecimal - 0 to 9 and A to F

Data of the correct type and length is expected; the data must be right justified with leading zeros. If an error occurs in entering data, depressing (CLR) will return all of the underscores and allows a complete restart of the data entry process. Once data of the correct type and length is entered, the operator depresses (ENT) and the data is stored. To signify that the data has been stored, the system has several responses:

1) If the minor level data item is the last item of a major level, the CDU is cleared after (ENT) is depressed.

2) If the data item is a forcing item, depressing (ENT) will result in displaying the next minor level of prompting with underscores.

3) If the data item is a non-forcing item, a $ appears in Display II when the data is entered to indicate to the operator that the MVUE accepted the input.

4.2.3 (Continued)

The operator has different options available depending on the system's response:

1) After supplying data to the last item of a major level, the system is returned to the COMMAND MODE; the operator may request any function available in the COMMAND MODE.

2) After supplying data to a forcing data item, data must be supplied to the next item in the set. The system will automatically advance the minor level and provide the underscores.

3) After supplying data to a non-forcing data item, the operator may select (.), (-), or (SEL). If (.) is selected, the minor level is advanced, a new minor code appears, and the operator has the options: (SEL), (.), (-), or (CLR).

4.2.4 Example of Time Input

Figure 4 gives an example of a prompting session to input a time of 14:30:15 on October 2, 1978, the 275th day of 1978 and to request that time output be displayed in the GPS system, a day-of-the-week and Greenwich-time system. The resulting CDU displays are shown to the right of the keystrokes.

4.2.5 Prompting Summary

In the COMMAND MODE:

SEL N	- Puts MVUE into PROMPTING MODE
	- Positions major prompting level at N
	- Sets minor prompting level at 0

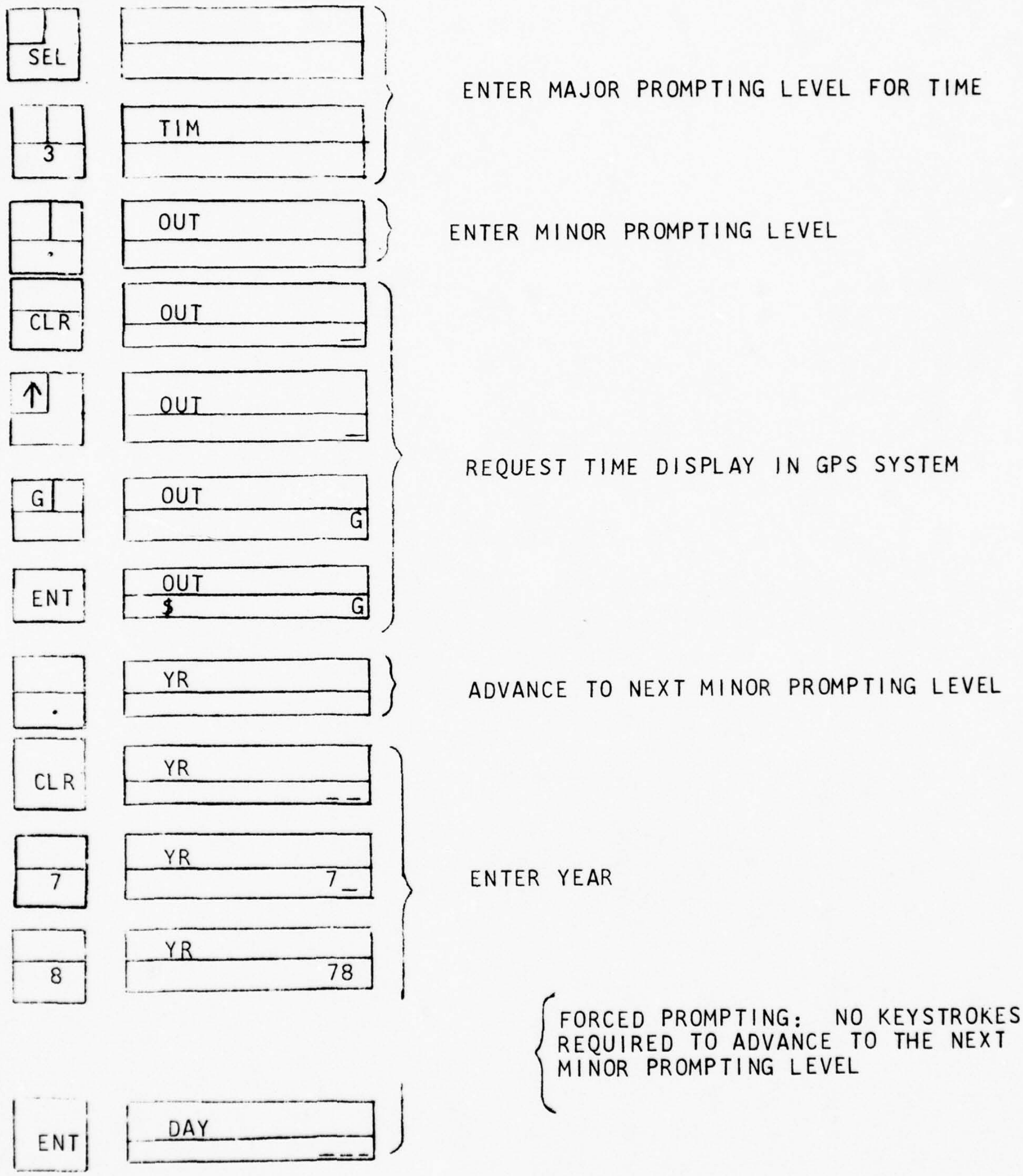


Figure 4. Example of Time Input

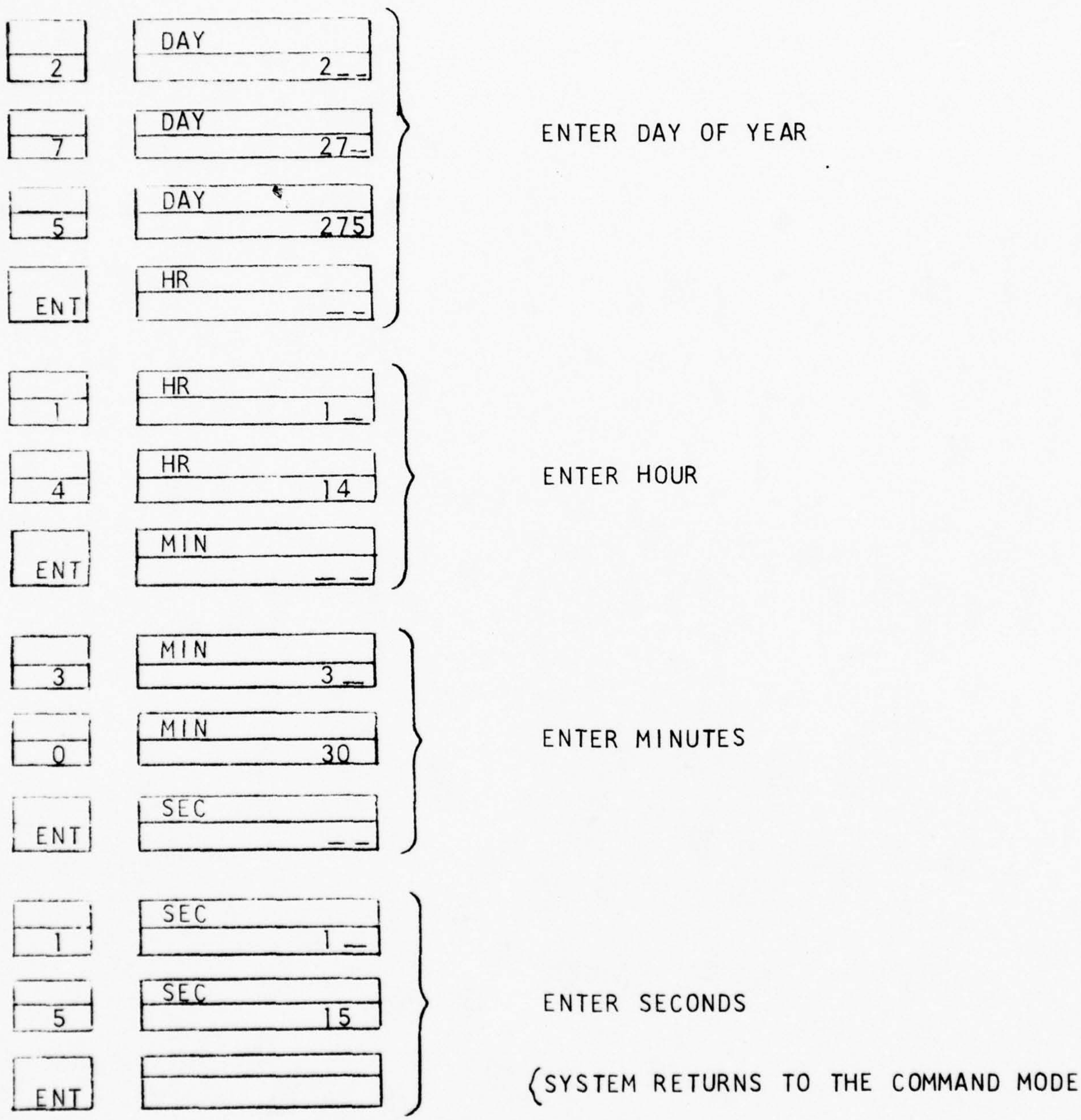


Figure 4. Example of Time Input (Continued)

4.2.5 (Continued)

In the PROMPTING MODE:

SEL	- Advances major prompting level by one (cycling to level 1 after level 9)
.	- Advances minor prompting level by one (advances to next major prompting level after last minor prompting level selection)
CLR	- Clears data from the input display
	- Replaces the data locations with underscores
	- Prepares for data entry
ENT	- Enters data from input display
-	- Removes MVUE from PROMPTING MODE

4.2.6 Error Handling Explanations

The MVUE informs the operator when an invalid command is received. To assist the operator in determining the valid commands available, error handling explanations for major level, minor level, and data entry errors will be given.

When the MVUE is at a major level of prompting, the MVUE is expecting (SEL), (.), or (-). If an alphanumeric character is entered, the character will be displayed in Display 20 and an "&" will be displayed in Display 1. If a function is entered, an "?" will appear in Display 1.

When the MVUE is at a non-forcing minor level of prompting, the MVUE is expecting (SEL), (.), (-), or (CLR). If an

4.2.6 (Continued)

alphanumeric character is entered, the character is displayed in Display 20 and an "@" is displayed in Display 1. If a function is entered, a "?" will appear in Display 1.

When the operator is supplying data in a minor level of prompting, the MVUE is expecting data of the correct type for each underscore followed by (ENT). If a function is entered, a "?" appears in Display 1; enter alphanumeric data. If a "?" appears in Display 1; enter alphanumeric data. If a "?" appears over an underscore, data of incorrect type was entered.

If the operator depresses (ENT) and all of the underscores reappear, the data entry was too short; enter an alphanumberic character for each underscore and press (ENT). If a "?" appears in Display 1 with all underscores replaced with data, the data entry was too long; if the data displayed is the desired value, depress (CLR) and re-enter the data in the fields provided. If all underscores are replaced with data, (ENT) is pressed, and underscores reappear, then the data supplied was out of range for the particular item; data of the correct magnitude must be supplied. If an undesired character is supplied during data entry, the operator may depress (CLR) and restart the data entry process.

4.3 Detailed Prompting Menu

The specific minor level prompting data items are described in the following tables. The tables are grouped in major level prompting classes. The letters under the heading Minor Level Code are the letters found in Displays 1, 2 and 3. The definition, data type, and range of data are also given for each minor level item. If the range of data is limited to two or three options, all valid options are listed. The heading, Forcing/Non-Forcing, describes whether an input item is a member of a logical input set, F-forcing, or an independent data item, NF-non-forcing. The notes contain any special information relating to the particular data item.

4.3.1 Waypoint Initialization in UTM/MGRS

Major prompting level 1 is used to input user position and waypoints in the UTM/MGRS system. Table III covers the minor prompting level details.

4.3.2 Altitude Initialization

Major prompting level 2 is used to initialize user altitude and is described in Table IV.

4.3.3 Time Initialization

Major prompting level 3 is used to initialize time and to define the time display format. It is described in Table V.

TABLE III

UTM (1)

MINOR LEVEL CODE	DEFINITION	DATA TYPE	RANGE OF DATA	FORCING/ NON-FORCING	NOTES
WPT	WAYPOINT NUMBER	DECIMAL	0 TO 8	NF	WAYPOINT 0 IS THE MVUE POSITION
SPH	DATUM NUMBER (SPHEROID)	DECIMAL	01 TO 46	NF	SPH=46 FOR WGS72, SEE TABLE XI FOR OTHER DATUM NUMBER DEFINITIONS
GRD	ZONE NUMBER +ZONE LETTER	2 DECIMAL 1 LIMITED ALPHA	00 TO 60 AND A TO Z (LESS I, O)	F	THE TWO DECIMAL DIGITS ARE SUPPLIED BEFORE THE LETTER. IF THE DECIMAL PORTION IS OUT OF RANGE, THE NUMBER MUST BE RE-ENTERED BEFORE THE LETTER CAN BE SUPPLIED. DEPRESSING (CLR), CLEARS BOTH THE DECIMAL AND LETTER FIELDS.
MG	MILITARY GRID LETTERS	2 LIMITED ALPHA	A TO Z (LESS I, O)	F	
ESG	EASTING	DECIMAL	00000 TO 99999	F	FIVE DIGITS MUST BE ENTERED.
NRG	NORTHING	DECIMAL	00000 TO 99999	F	FIVE DIGITS MUST BE ENTERED.

TABLE IV

ALT (2)

MINOR LEVEL CODE	DEFINITION	DATA TYPE	RANGE OF DATA	FORCING/ NON-FORCING	NOTES
ALT	MEAN SEA LEVEL ALTITUDE	DECIMAL	-9999 TO 09999	NF	ALTITUDE IS LIMITED TO 4 DIGITS OF DECIMAL DATA. NEGATIVE ALTITUDE IS PRECEDED WITH A (-); POSITIVE ALTITUDE IS PRECEDED WITH A (0). THE ALTITUDE IS EXPRESSED IN METERS.

TABLE V

TIM (3)

MINOR LEVEL CODE	DEFINITION	DATA TYPE	RANGE OF DATA	FORCING/ NON-FORCING	NOTES
OUT	TIME DISPLAY SYSTEM	LIMITED ALPHA	Z OR G	NF	Z-ZULU (24 HOUR CLOCK - JULIAN DATE) G-GPS (24 HOUR CLOCK - DAY OF WEEK) DEFAULT=ZULU
YR	YEAR	DECIMAL	78 TO 99	F	1978 TO 1999
DAY	DAY OF YEAR	DECIMAL	000 TO 366	F	JANUARY 1 = DAY 1
HR	HOUR	DECIMAL	00 TO 23	F	GREENWICH TIME
MIN	MINUTE	DECIMAL	00 TO 59	F	
SEC	SECOND	DECIMAL	00 TO 59	F	

4.3.4 Options

Major prompting level 4 is used to define various system options and enter the free text mode for radio/DMD operation. It is described in Table VI.

4.3.5 Options continued

Major prompting level 5 continues system options. It is described in Table VII.

4.3.6 Built-In-Test

The Built-In-Test mode is entered with major prompting level 6 as shown in Table VIII.

4.3.7 SV Constellation Initialization

The desired SV constellation can be initialized by the operator using major prompting level 7. A combination of SV's and/or ground transmitters can be input. The minor prompting levels are described in Table IX.

4.3.8 Memory Read/Write

4.3.8.1 Memory Read

Memory Read/Write is a special feature which allows the operator to inspect memory and modify its contents. The major prompting level is identified by MEM in displays 1, 2, and 3. By depressing (.), the minor level of prompting is entered. When the minor level of prompting is entered, the following is displayed:

TABLE VI

OPT (4)

MINOR LEVEL CODE	DEFINITION	DATA TYPE	RANGE TO DATA	FORCING/ NON-FORCING	NOTES
MIS	REQUEST MAN-PACK INSTRUMENTATION SYSTEM	LIMITED ALPHA	Y OR N	NF	Y-AUTHORIZE MIS N-RESCIND MIS AUTHORIZATION DEFAULT-N
RAD	RADIO BAUD RATE	DECIMAL	0300, OR 0600, OR 1200	NF	DEFAULT IS 0300
EPH	EPHEMERIS UPDATE AUTHORIZATION	LIMITED ALPHA	Y OR N	NF	Y-AUTHORIZE EPHEMERIS UPDATE N-RESCIND EPHEMERIS UPDATE DEFAULT-Y
MOV	MVUE DYNAMICS (MOVING)	LIMITED ALPHA	Y OR N	NF	Y-MOVING N-STATIONARY (NOT MOVING) DEFAULT-Y
ACQ	SV ACQUISITION AUTHORIZATION	LIMITED ALPHA	Y OR N	NF	Y-AUTHORIZE SV ACQUISITION N-RESCIND SV ACQUISITION DEFAULT-Y
TXT	FREE TEXT	FREE TEXT	UP TO 20 ALPHA-NUMERIC OR PUNCTUATION CHARACTERS	NF	UNDERSCORES APPEAR IN ALL 20 DISPLAYS. UP TO 20 CHARACTERS MAY BE ENTERED IN THE MESSAGE. THE FIRST CHARACTER WILL BE USED AS A DMD CODE LETTER. THE MESSAGE IS TERMINATED BY (ENT) AND THEN (RAD), OR BY (RAD).

TABLE VII

OP2 (5)

MINOR LEVEL	DEFINITION	DATA TYPE	RANGE OF DATA	FORCING/ NON-FORCING	NOTES
ALM	AUTOMATIC ALMANAC ACQUISITION	LIMITED ALPHA	Y OR N	NF	Y-ENTER ALMANAC ACQUISITION MODE N-ENTER NORMAL ACQUISITION MODE DEFAULT - N
RST	SOFTWARE RESTART REQUEST	LIMITED ALPHA	Y OR N	NF	Y-COMMANDS RESTART IMMEDIATELY N-NO ACTION DEFAULT - N
RAM	RAM ALMANAC SELECT FLAG	LIMITED ALPHA	Y OR N	NF	Y-SETS RAM ALMANAC SELECT FLAG N-ALLOWS ROM ALMANAC TO BE COPIED TO RAM DEFAULT - N
ION	IONOSPHERIC CORRECTION	LIMITED ALPHA	Y OR N	NF	Y-INCORPORATE BOTH IONOSPHERIC AND TROPOSHERIC CORRECTION N-INCORPORATE ONLY THE TROPOSHERIC CORRECTION DEFAULT - Y
ATM	ATMOSPHERIC CORRECTIONS (IONOSPHERIC & TROPOSPHERIC	LIMITED ALPHA	Y OR N	NF	Y-INCORPORATE BOTH CORRECTIONS N-INCORPORATE NEITHER CORRECTION DEFAULT - Y

TABLE VIII

BIT (6)

MINOR LEVEL	DEFINITION	DATA TYPE	RANGE OF DATA	FORCING/ NON-FORCING	NOTES
NUM	BUILT-IN-TEST LEVEL NUMBER	DECIMAL	01 TO 05	NF	THE BIT LEVEL NUMBER REPRESENTS THE FIRST LEVEL OF MODULE TEST ING TO BE PERFORMED. THE BIT SOFTWARE WILL CONTINUE TESTING UNTIL LEVEL 05 OR UNTIL AN ERROR HAS BEEN ENCOUNTERED. FURTHER DETAILS ON BIT MAY BE FOUND IN SECTION 5.1.

TABLE IX

SV (7)

MINOR LEVEL CODE	DEFINITION	DATA TYPE	RANGE OF DATA	FORCING/ NON-FORCING	NOTES
SV 1	SPACE VEHICLE 1 (GROUND TRANSMITTER 1)	DECIMAL	00 TO 37	F	
SV2	SPACE VEHICLE 2 (GROUND TRANSMITTER 2)	DECIMAL	00 TO 37	F	
SV3	SPACE VEHICLE 3 (GROUND TRANSMITTER 3)	DECIMAL	00 TO 37	F	
SV4	SPACE VEHICLE 4 (GROUND TRANSMITTER 4)	DECIMAL	00 TO 37	F	
SV5	SPACE VEHICLE 5 (GROUND TRANSMITTER 5)	DECIMAL	00 TO 37	F	
SV6	SPACE VEHICLE 6 (GROUND TRANSMITTER 6)	DECIMAL	00 TO 37	F	IF ALL SV's ARE ENTERED AS ZERO, THEN A NEW CONSTELLATION WILL BE CHOSEN BY THE MVUE.

1) ADR in Displays 1, 2 and 3 (identifying the address to be inspected)

2) < in Display 6 (signifying that the address will be expressed in hexadecimal)

3) a four digit hexadecimal address displayed in locations 7, 8, 9, and 10.

The address displayed is the last address monitored by memory read/write. If no address had been monitored, AAAA will be used as a default value.

(CRL) and (ENT) are the only two acceptable commands. (CRL) replaces the address with underscores and allows for a new four digit hex address to be entered. If a minus is depressed in the place of hex input, the Memory Read/Write session is terminated. (ENT) will cause the MVUE to display the memory address in the following format:

1) CNT in Displays 11, 12 and 13

2) < in Display 16

3) the memory contents displayed in locations 17, 18, 19, and 20.

After completing the memory read cycle, a new command is required; (CLR), (.), and (-) are the available options. A minus terminates the memory read/write session and returns the system to the command mode. A period increments the address that was read by two, clears the CDU, and displays the new address. If the operator depresses (CLR), the memory write process is started.

4.3.8.2 Memory Write

The memory write process can only be entered from the memory read process as described in 4.3.8.1. The operator must read the contents of the address to be modified and press the (CLR) key to enter new data. Four underscores replace the old memory contents and a four digit hex number is requested. The operator may enter the new memory contents or enter a minus to terminate the memory read/write session. When a new hex value has been entered and (ENT) is depressed, the memory location is modified. The contents of the modified address are read and displayed. The system completes the memory read cycle and is expecting a (CLR), (.), or (-) command from the operator.

The memory is divided into three pages in an MVUE system. Addresses < 0000 to < 3FFF, < C000 to < EFFF and < FA00 to < FFFF are in page 0. Pages 1 and 2 share address locations < 4000 to < BFFF. A page indicator word has been set up to allow the operator the ability to specify which page will be read or modified. The location of the page indicator is determined from the load module memory map. It is labeled XMRWPG in page 0. To select page 1 or 2 the operator will modify the contents of this address using the memory write function. Information on page 0 is always in memory; the correct address will be used for all values of the page indicator word. When information on page 1 or 2 is desired,

4.3.8.2 (Continued)

the correct value of 1 or 2 must be supplied. The page indicator word is not reset in a memory read/write session. Multiple operations on a given page are possible with only one modification of the page indicator word.

4.3.9 Waypoint Initialization In Latitude/Longitude

Waypoints and user position in latitude/longitude can be initialized using major prompting level 9. The minor prompting levels are described in Table X. The 46 spheroid numbers are given in Table XI.

5.0 COMMAND MODES

5.1 Automatic Mode

The automatic mode is a feature which allows an MVUE in a steady state tracking condition to display a CDU function once every minute. The functions invoked by the GRD, LAT, TIM, RNG, ALT, and FIX buttons are included. The last of these functions displayed in the manual mode will become the automatic mode display function. The default is FIX. The automatic mode is entered by switching the (AUTO/MAN) switch to AUTO and depressing (ENT). A function is displayed within a minute and at one minute intervals thereafter. The display remains on for ten seconds. The operator terminates the automatic mode by switching the (AUTO/MAN) switch to MAN and

TABLE X LAT (9)

MINOR LEVEL CODE	DEFINITION	DATA TYPE	RANGE OF DATA	FORCING/ NON-FORCING	NOTES
WPT	WAYPOINT NUMBER	DECIMAL	0 TO 8	NF	WAYPOINT 0 IS THE MVUE POSITION
SPH	DATUM NUMBER (SPHEROID)	DECIMAL	01 TO 46	NF	SPH=46 FOR WGS72, SEE TABLE XI FOR OTHER DATUM NUMBER DEFINITIONS
DIR	LATITUDE DIRECTION	LIMITED ALPHA	N, S	F	N-NORTH OF EQUATOR S-SOUTH OF EQUATOR
DEG	DEGREES OF LATITUDE	DECIMAL	00 TO 90	F	
MIN	MINUTES OF LATITUDE	DECIMAL	00 TO 59	F	IF DEG=90, THEN MIN=00 WILL OVERRIDE NON-ZERO OPERATOR INPUT
SEC	SECONDS OF LATITUDE	DECIMAL	000 TO 599	F	SECONDS OF LATITUDE EXPRESSED IN TENTHS OF SECONDS. IF DEG=90, THEN SEC =000 WILL OVERRIDE OPERATOR INPUT
DIR	LONGITUDE DIRECTION	LIMITED ALPHA	E, W	F	E-EAST OF GREENWICH W-WEST OF GREENWICH
DEG	DEGREES OF LONGITUDE	DECIMAL	000 TO 180	F	E-179° MAXIMUM W-180° MAXIMUM
MIN	MINUTES OF LONGITUDE	DECIMAL	00 TO 59	F	IF DEG=180, THEN MIN=00 WILL OVERRIDE NON-ZERO OPERATOR INPUT
SEC	SECONDS OF LONGITUDE	DECIMAL	000 TO 599	F	SECONDS OF LONGITUDE EXPRESSED IN TENTHS OF SECONDS. IF DEG=180, THEN SEC =000 WILL OVERRIDE OPERATOR INPUT

TABLE XI

DATUM NUMBER DEFINITIONS

SPH	GEODETIC DATUM
1	ADINDAN
2	ARC 1950
3	AUSTRALIAN GEODETIC
4	BUKIT RIMPAH
5	CAMP AREA ASTRO
6	CHATHAM OBSV. 1950
7	DJAKARTA
8	EUROPEAN
9	GEODETIC DATUM 1949
10	GHANA
11	GUAM 1963
12	G. SEGARA
13	HERAT NORTH
14	HJORSEY 1953
15	HU-TZU-SHAN
16	INDIAN
17	KERTAU
18	LIBERIA 1964
19	ASCENSION ISLAND ASTRO 1958
20	CANTON ISLAND ASTRO 1966
21	JOHNSON ISLAND ASTRO 1961
22	WAKE ISLAND ASTRO 1952
23	LUZON

TABLE XI

DATUM NUMBER DEFINITION (Continued)

SPH	GEODETIC DATUM
24	MONTJONG LOWE
25	NIGERIA
26	NORTH AMERICAN 1927 - CONUS
27	NORTH AMERICAN 1927 - ALASKA & CANADA
28	OLD HAWAIIAN - MAUI
29	OLD HAWAIIAN - OAHU
30	OLD HAWAIIAN - KAUAI
31	ORDINANCE SURVEY OF GREAT BRITAIN 1936
32	QORNOQ
33	SIERRA LEONE 1960
34	SOUTH AMERICAN 1969
35	PROVISIONAL SOUTH AMERICAN 1956
36	CORREGO ALEGRE
37	CAMPO INCHAUSPE
38	CHUA ASTRO
39	YACARE
40	TANANARIVE OBSV. 1925
41	TIMBALAI
42	TOKYO
43	WAKE - ENIWETOK 1960 - KWAJALEIN ATOLL
44	WAKE - ENIWETOK 1960 - WAKE ISLAND
45	WAKE - ENIWETOK 1960 - ENIWETOK ATOLL
46	WGS 72

5.1 (Continued)

depressing (ENT). The MVUE is dedicated to producing function displays at one minute intervals in the automatic mode. Other commands are prohibited until the automatic mode is terminated. If the operator presses an illegal key the display will show a "?" or a flashing "X" in Display 1 to indicate that the keystroke was not accepted.

5.2 Manual Mode

The manual mode is a state of the MVUE which allows the operator to command various functions to be performed. When a command is detected, the MVUE will service the function before accepting the next command. The commands can be organized into three groups: informative functions, prompting functions, and radio transmission. The informative functions are (GRD), (LAT), (TIM), (RNG), (ALT), and (FIX). The informative functions provide the operator with a ten second display of the requested parameters. The prompting functions are (ENT), (SEL) (Upper left), (CLR), and (Upper right). The prompting functions allow the operator to use the CDU keyboard to supply data to the MVUE. The radio transmission function permits the contents of the CDU display to be transmitted to a DMD device. A description of the informtive functions and radio transmission function will follow.

The MVUE will respond with a "?" in Display 1 when a non-function keystroke is entered in the manual mode.

A flashing "X" will appear in Display 1 if:

1) the operator depresses (CLR)

2) the operator depresses (FIX) or (ALT) before the first fix

3) the operator depresses any function after initialization and before the first fix.

5.2.1 Waypoint Display in UTM/MGRS

The (GRD) key is used to display the coordinates of a waypoint in UTM/MGRS. The coordinates are initially supplied by the operator through prompting. The operator uses the UTM or LAT major levels to supply the coordinates of a maximum of eight waypoints. When the operator depresses (GRD), the last waypoint referenced is displayed. The waypoint reference may be changed from the last initialized waypoint to a previously supplied waypoint by entering prompting and supplying the number of another initialized waypoint. If waypoint 0 (user position) is the current number and it had been initialized in LAT, an incorrect display will be given, followed by a flashing # to indicate an illegal operation since waypoint 0 is not a true waypoint. The format of the display is described in Figure 5.

5.2.2 Waypoint Display in Latitude/Longitude

The (LAT) key is used to display the coordinates of a waypoint in latitude and longitude. The coordinates are initially supplied by the operator through prompting. The

FUNCTION/KEYSTROKE		DISPLAY	
RNG		W R G X X X X X A Z Y Y Y	W-WAYPOINT # X-METERS Y-DEGREES
ALT		/-H X X X X X N S Y Y Y Z Z Z	X-ALTITUDE Y-CEP Z-PE N-# OF SV's TRACKED
TIM	GPS	D Y D G H R H H M M S S	Y-YEAR D-DAY H-HOUR M-MINUTE S-SECOND
	ZULU	D Y Y Y D D D Z H R H H M M S S	
GRD	(OR FIX OR AUTO)	W C C E E E E E D A A B N N N N N D	W-WAYPOINT # A-UTM # B-UTM LETTER C-MGRS LETTERS D-DATUM # E-EASTING N-NORTHING
LAT	(OR FIX OR AUTO)	D D N/S Y Y Y Y Y Y Y W E/W X X X X X X X X	W-WAYPOINT # D-DATUM # X-LONGITUDE Y-LATITUDE

Figure 5. CDU Display Formats

operator uses the UTM or LAT Major levels to supply the coordinates of a maximum of eight waypoints. When the operator depresses (LAT), the last waypoint referenced is displayed. The waypoint reference may be changed from the last initialized waypoint to a previously supplied waypoint by entering prompting and supplying the number of another initialized waypoint. If waypoint 0 (user position) is the current number and it had been initialized in GRID, an incorrect display will be given, followed by a flashing # to indicate an illegal operation since waypoint 0 is not a true waypoint. The format of the display is described in Figure 5.

5.2.3 Time Display

The (TIM) key is used to display the current user time. Time is a required initialization parameter. The operator chooses between the GPS and ZULU time display systems during the time initialization session. The GPS system displays time in Greenwich time and day of the week; the ZULU system displays time in Greenwich time, day of the year, and year. The formats for time are described in Figure 5.

5.2.4 Waypoint Range/Bearing Display

The (RNG) key displays the range and bearing to the last referenced waypoint. The range is expressed in meters and represents ground range between the user and the waypoint. The bearing is the waypoint's angular difference from North expressed in degrees. The format of range and

bearing display is shown in Figure 5.

5.2.5 Altitude Display

The (ALT) key controls the display of altitude, CEP, and the number of SV's being tracked. Altitude and Center of Equal Probability (CEP) are expressed in meters. If altitude is negative, a minus will appear in Display 3. The format for altitude display is found in Figure 5.

5.2.6 FIX Display

The (FIX) key allows the MVUE to display the user's position on command. Fixes may be commanded only after the first fix has been displayed. The users position is displayed in the latitude/longitude system or the UTM/MGRS depending on the last coordinate system referenced in position input, waypoint input, or waypoint display. The position appears on the CDU display within ten seconds of the (FIX) keystroke, and the value represents the user's position at the time of display projected from the user's position and velocity at the time the key was depressed. The UTM/MGRS position format or the position format for latitude and longitude from Figure 5 will be used.

5.2.7 Radio/DMD

The (RAD) key allows the contents of the CDU display to be transmitted via radio to a DMD. The letter in Display 1 is used as the DMD identifying letter. The display is cleared after (RAD) is depressed, but multiple (RAD) keystrokes will allow multiple transmissions of the message

to be sent. The first non-(RAD) keystrokes after a radio transmission clears the transmission buffer.

The operator may use the free text mode in prompting to create a 20 character message to be transmitted. The first characteris is used as the DMD identifying letter.

The identifying letter may be added to an existing CDU display by using ID Prompting. ID Prompting is entered by depressing (Upper left) and then (SEL). An underscore appears in Display 1 and one free text character is expected. After entering the character, the session is terminated with (ENT) and (RAD), or with (RAD).

6. SYSTEM OPERATION MODES

6.1 Built-In-Test

Built-In-Test (BIT) is a self-test mode in the MVUE which tests the hardware performance and displays the result of the test. Built-In-Test consists of fourteen (14) tests of the hardware performed serially. BIT is inititated through prompting and requires a starting test number to be supplied by the operator (See Table VIII). The starting test and all following tests will be performed until the fourteenth test has been successfully completed or until a hardware failure has been detected. The MVUE displays a two character code in Display 1 and 2 to inform the operator of the status of the test. The code for the test that failed or "OK" for a successful test of the hardware will remain displayed on the CDU until the

operator initiates some other CDU activity. It is not necessary to first clear the display. Whatever the results of BIT testing the operator can attempt to continue with further system operation. Either a RESTART or a WARMSTART must be executed if the operator desires to attempt acquisition after BIT testing. Table XII lists the two letter codes and their definitions for the BIT mode.

One test in BIT requires the operator to exercise the keyboard. The beginning of the keyboard test is signified by a flashing 0. The operator performs the following sequence of CDU keystrokes:

TABLE XII

BUILT-IN-TEST CODES

NUMBER	CODE	DEFINITION
1	OS	10 MHZ REFERENCE OSCILLATOR
2	E1	EIOM
3	KB	KEYBOARD
4	LO	LOCAL OSCILLATOR
5	MO	MEASUREMENT OUTPUT
6	VC	VCXO CALIBRATION
7	RR	RANGE RANGE COUNTER
8	VS	VCXO SET
9	OM	OUTPUT MODULE
10	L1	L1 SEARCH
11	L2	L2 SEARCH
12	DR	DATA RECOVERY
13	BS	BIT SYNCHRONIZATION
14	PR	PROCESSOR, MEMORY, OR OPERATOR ERROR
15	OK	TESTS COMPLETED SUCCESSFULLY

6.1 (Continued)

1) Depress GRD

2) Depress LAT

3) Depress TIM

4) Depress 6

5) Depress 8

6) Depress -

After completing the keyboard test, the MVUE continues with the remaining BIT tests.

6.2 System Warning Messages

The MVUE uses System Warning Message as the mechanism to inform the operator that the MVUE needs operator intervention to start or maintain a normal operating status. The messages appear as one character codes displayed in Display 1. The message flashes for ten seconds before the CDU is cleared. The warning messages are listed in Table XIII with their definitions. The warning messages are displayed once. The operator may find the table of messages by adding six to the starting address of the common block MBCCST in the memory map of the load module. Using memory read/write the array of twenty messages may be inspected. Non-zero entries in the array signify the corresponding warning messages have been displayed or are pending display.

TABLE XIII

SYSTEM WARNING MESSAGES

NUMBER	MESSAGE DISPLAY	DEFINITION
1	B	LOW BATTERY
2		NOT USED
3	E	NEED EPHEMERIS UPDATE AUTHORIZATION
4	F	FATAL SYSTEM ERROR
5		NOT USED
6	I	INITIALIZATION REQUIRED FOR FIRST FIX
7		NOT USED
8	P	POSITION ERROR EXCESSIVE
9	R	RECEIVER FAILURE
10	S	TOO FEW SV's
11	T	EXCESSIVE REACQUISITION TIME
12	K	CLOCK ERROR EXCESSIVE
13	Z	SYSTEM VARIABLE PREVIOUSLY INITIALIZED
14		NOT USED
15	W	PROCESSOR ERROR
16	X	OPERATOR INPUT PROHIBITED
17	0	INITIATE KEYBOARD TEST (BIT)
18	G	SV C/NO BELOW THRESHOLD
19	?	ILLEGAL KEYSTROKE OBTAINED
20		NOT USED

6.3 Acquisition

After position and time have been initialized depressing the FIX button causes normal SV acquisition to begin. An acquisition status display will be made every 30 seconds until the first fix is displayed. The format of this display is described by Figure 6. During acquisition CDU input is prohibited. Any Keystroke will result in a flashing "X" display for ten seconds. At least 3 transmitters must be acquired in acquisition in order to begin sequencing. If less than 3 are acquired the system will do an automatic RESTART, and control will be returned to the operator.

6.4 Automatic Alamanc Acquisition

An alamanc will be collected and stored in RAM in a successful execution of the Automatic Almanac Acquisition Mode. The user selects this option during initialization by entering "Y" (yes) for the ALM option in prompting (see Table VII). Depressing the FIX button will then begin the special almanac collection acquisition mode. If SV's were input by the operator only those will be searched for until one is acquired. If SV's were not input the system will search first for the SV's which the PROM almanac indicates are visible and then in sequence for SV identities 1-9 which were not indicated as visible. The search continues only until one SV is acquired. Now the system will recover almanac data for all SV's from the acquired SV and place this new almanac in the RAM almanad data set. The RAM almanac select flag will also be set so that this almanac will remain in force until a COLDSTART is executed or the RAM flag is reset by prompting.

DISPLAY

V	I	S		A	C	Q		I	D

	X	X			Y	Y		Z	Z

X - Number of visible SV's according to calculations based on the SV almanac currently being used

Y - Number of SV's which have been acquired so far for sequencing

Z - The SV identification number of the SV for which the Receiver is currently searching. SV's are 1-24 and GT's are 33-36.

Figure 6. Acquisition Status Display

6.4 (Continued)

If the attempt to collect an almanac fails the system will automatically RESTART and control will be returned to the operator. If the almanac collection is successful the system will also automatically RESTART, but will additionally automatically continue on with normal SV acquisition using the new almanac.

6.5 COLDSTART

COLDSTART refers to the normal system start-up from power off or after the processor has been halted and reset. COLDSTART is characterized by the flashing "I", initialization required warning message.

6.6 STANDBY/WARMSTART

STANDBY refers to the MVUE RAM memory preserved mode. When the CDU switch is positioned to STANDBY, power is on only to preserve RAM memory and to keep the oscillator warm. If precision time had been calculated then when the CDU switch is positioned ON the MVUE executes a WARMSTART. In this case initialization is preserved and the MVUE automatically goes on to the Acquisition mode.

6.7 RESTART

RESTART refers to the MVUE software function which resets and restarts the processor. Initialization is preserved but the system is left in the initialization mode so the user may

6.7 (Continued)

reinitialize any parameters he chooses. A RESTART can be operator commanded through prompting (see Table VII). A RESTART is system commanded after several system failure conditions, for example, failure to acquire enough SV's.

6.8 Altitude Hold

Altitude Hold is the MVUE Navigation system feature which allows accurate navigation with 3 transmitters. Altitude Hold essentially replaces the other needed transmitter source with a range to the center of the earth measurement based on altitude. An accurate altitude is required for accurate navigational performance. If no altitude was entered mean sea level is assumed. If the system has 4 transmitters and then drops to 3 transmitters the latest system computed altitude is assumed. The operator may enter altitude through prompting at any time he feels the system altitude is incorrect.

6.9 Degraded Operation/2 Transmitters

If the MVUE is sequencing drops to only 2 available transmitters Navigational system operation is continued by freezing updates to the MVUE Navigational state time components. This prevents rapid drifting of the Navigation solution but does not insure accurate Navigation. Operation is continued in this mode to allow the system time to find and acquire another transmitter if possible. System failure can be eventually expected if

6.9 (Continued)

another transmitter is not found. Altitude Hold is being used as one Navigation Measurement in this degraded mode operation.

6.10 System Operation with Rising and Setting SV's

If the operator does not select on SV constellation the MVUE Navigation system will automatically drop setting SV's and attempt to acquire rising SV's up to a maximum of 6 SV's. With a full system of 24 orbiting SV's this feature allows continuous operation. If SV's were operator selected only those SV's will be used and they will not be dropped when they are about to set but will be tracked until they are lost.

APPENDIX B

MASTER STATE SV REACQUISITION AND NAVIGATION CONTROL VARIABLE LIST

APPENDIX B

MASTER STATE SV REACQUISITION AND NAVIGATION CONTROL VARIABLE LIST

NAME	MEANING
MBCCNT	Msg Available for Display by CDU
MBCMSG	Msg to be Displayed to CDU
MBSVFR	First Fix Request Flag 0-FF Not Requested, 1-FF Requested
MCSTAT	SV STATUS 0 - Not Defined 1 - SV Reacquired W/P Code and Tracking 2 - SV Reacquired W/C/A Code (awaiting P reacq) 3 - SV Acquired but not Reacquired 4 - SV Failed to be Acquired the First Time 5 - Not Used 6 - SV Failed to be Acquired with P Code 7 - SV Acquired in Mode 8 (new SV Acq) 8 - Not Used 9 - Not Used 10 - SV Failed to Hand Over to P Code in S.S. 11 - SV Reacq Timed out -commanded in mode 24 12 - SV C/A Reacq Time out - tried 4 minute C/A Reacq 13 - SV Reacq timed out-Good Snr-CMDED in mode 5 14 - SV just set-no replacement found 15 - SV has set-ignore measuremets 16 - New SV acquired in S.S, can't collect EPHM 17 - SV just set - replacement Found
MCTNER	Data Block Collection Status 0 - Data not collected 1 - Sync Error or Roll Momentum Dump -1 - Data collected
MFBUF1	Each Element Contains the Corresponding Almanac ID
MNAICD	Aiding Command to Navigation
MNALTI	Command Altitude Hold for Inner Loop
MNALTM	SV Altitude Hold Mode
MNALTO	Command Altitude Hold for Outer Loop

MNPION	Ionospheric Correction SV Number
MNPSTK	Number of SV's being tracked
MNPSVI	Inner Loop SV Number
MNPSVO	Outer Loop SV Number
MNSMOD	SV Replacement Task Mode
MNSNEW	SV Replacement Reason 0 - Normal Replacement Due to Signal Loss 1 - New SV to be added to sequence -1 - Replace Setting SV
MNSREP	SV Replacement Number
MNSSET	Setting SV Flag
MQCAFL	Time Constant for C/A Reacq Failure
MQEPHM	Operator Approval - Full Ephemeris Update
MQNEPM	Operator Approval - New SV Search
MQNWSV	Time Constant for New SV Search
MQPCFL	Time Constant for P Code Reacq Failure
MQPRFL	Time Constant for SV Reacq-Mod 24
MQTMOL	Time Constant for Outer Loop Period
MQ1PFL	Time Constant for C/A to P Handover Failure
MQTEPH	Time Constant for EPHM UPDATE
MRCGID	SV Receiver Command
MRCMOD	SV Receiver Mode 4 - C/A Reacq 5 - P Reacq 6 - Ionospheric Correction 8 - SV Reacquisition 24 - SV Reacquisition
MVAHSV	SV on which altitude hold is being done
MVAHTP	Drop Altitude hold on current SV 0 - do nothing 1 - drop A.H.
MVDCTR	8 sec. counter to display first fix

MVDUMY	Buffer space in data set
MVELVT	SV elevation array for master state
MVEMSQ	Has EPHM approval been requested TRUE - YES, FALSE - NO
MVEPDC	SV Ephemeris Data Flag 0 - No Ephemeris collected 1 - Ephemeris collected, waiting for fits -1 - fits computed, waiting for gains to put SV into system
MVEPHF	SV Ephemeris collection reason 0 - Full EPHM 1 - New SV EPHM -1 - Full SV EPHM with new SV Acq.
MVEPHM	Ephemeris module entry flag 0 - not due or completed -1 - Due, but not operator approved 1 - in progress
MVEPIN	SV EPHEMERIS ID
MVERCI	Was EPHM Receiver Command Issued 1 - YES, 0 - NO
MVESNR	C/NO Measurement Array
MVFFFS	Has First Fix Flag Been Set 1 - YES, 0 - NO
MVFSTS	Have We Issued the first EPHM Mode 7 1 - NO, 0 - YES
MVFSVF	Has 'too few SV's' msg been sent TRUE - YES, FALSE - NO
MVFTFI	Ephemeris FTF initialization Flag
MVICPR	IONO SV Pointer
MVIESV	Ephemeris SV ID Counter
MVIICC	Iono Mode 6 Command
MVIOCF	Iono Status Flag TRUE - In Progress, FLASE - Not In Progress
MVIOLP	Outer Loop Counter
MVISVX	SV ID Counter

MVNRHF	Number of Rcvr Hardware Failures Reported
MVNSSF	Not Used
MVNSSW	New SV Search Status TRUE - We Are Searching, FALSE - We Aren't
MVNSVE	New SV Acquired Pointer
MVOLAS	Outer Loop Started Flag per SV
MVOLGC	Has Outer Loop Gains Finished the First Time 1 - HAS, 0 - HASN'T
MVOLHS	Has Outer Loop Started so we can drop A.H. from this acquired SV
MVREPL	SV Replacement Status (1,N) - Replacement Status -1 - waiting to be replaced -2 - waiting to be requested 1 - replacement was not found 2 - replacement was found (2,N) - Replacement Reason Copy of MNSNEW
MVRFFM	Has 'RCVR FAILURE' msg been sent to CDU
MVRSTA	Receiver Status Loop Counter
MVSFTF	FTF at Start of EPHM Update
MVSSWM	Search Request made to operator?
MVSVTK	Save Array for prior two SV's commanded
MVSVTR	Number of SV's being sequence (does not include Mode 8's)
MVTEPH	Full EPHM one hour timer
MVTOCK	24 second outer loop clock
MVTPRA	SV Timer Array (1, N) 0 - Timer Off 1 - Timer On (2, N) Number of seconds timed so far (Failure Time)
MVTRMD	Save Array for prior Two RCVR. Modes.
NMAVIS	Number of SV's visible
NMICNG	Filter divergence Flag

NMIFIT	Fit coefficient computation flag
NMIGCM	Gains complete flag
NMINGC	Gains computed flag
NRAID1	NAV Aiding Data
RMASNR	SNR Value per SV
RMMSTA	Receiver Status 5 - Hardware Failure
RMMVAL	Measurement Validity Flag -1 - Good New Measurement 0 - Bad Measurement 1 - Good Old Measurement

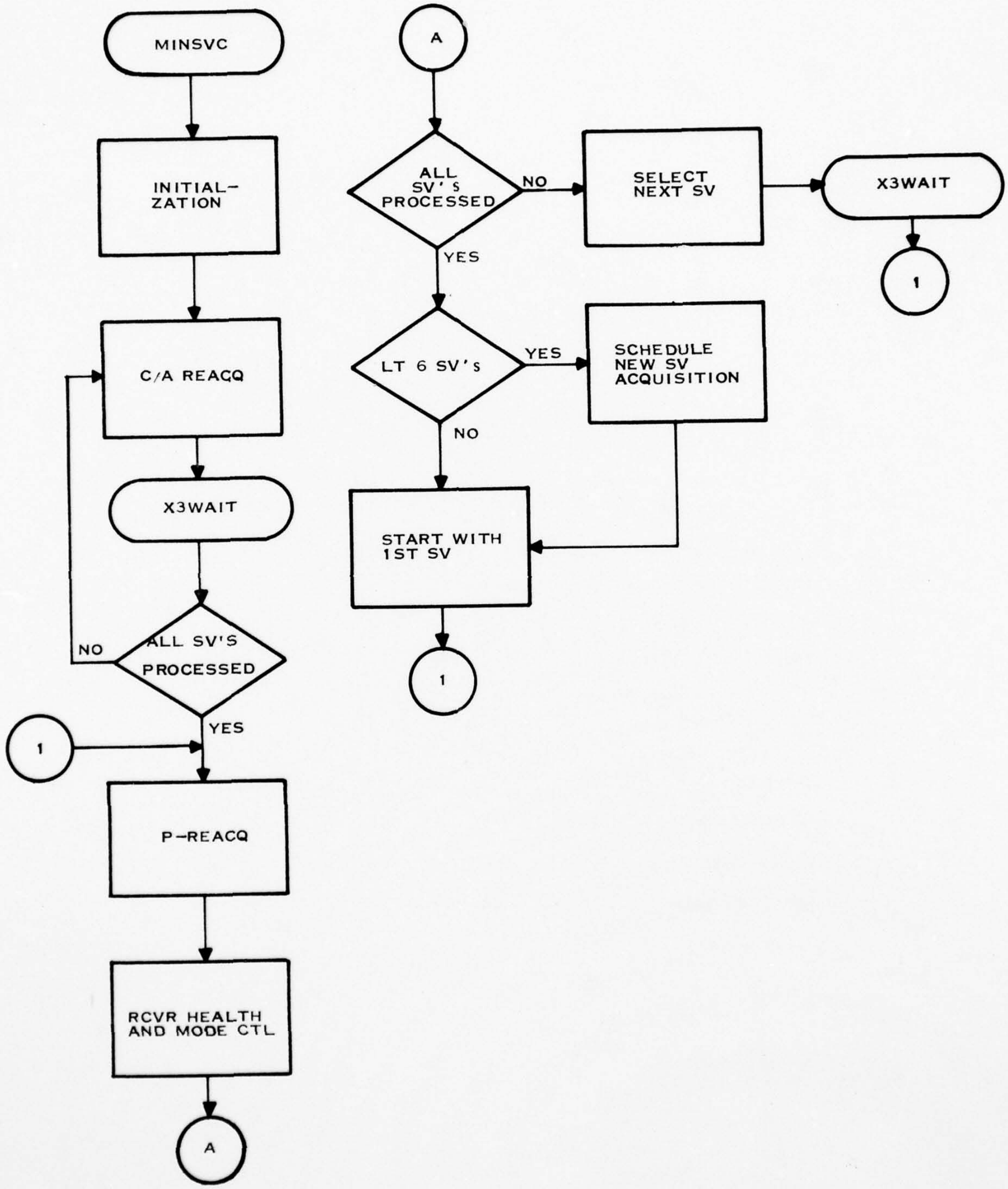
APPENDIX C

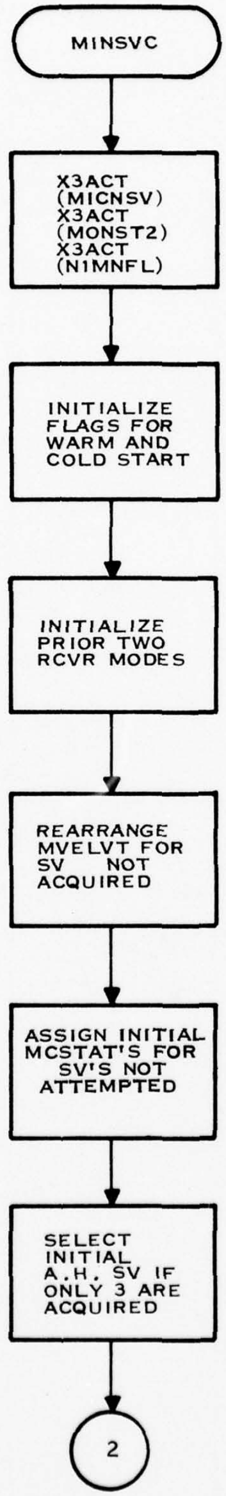
SELECTED MASTER CONTROL MODULE FLOWCHARTS

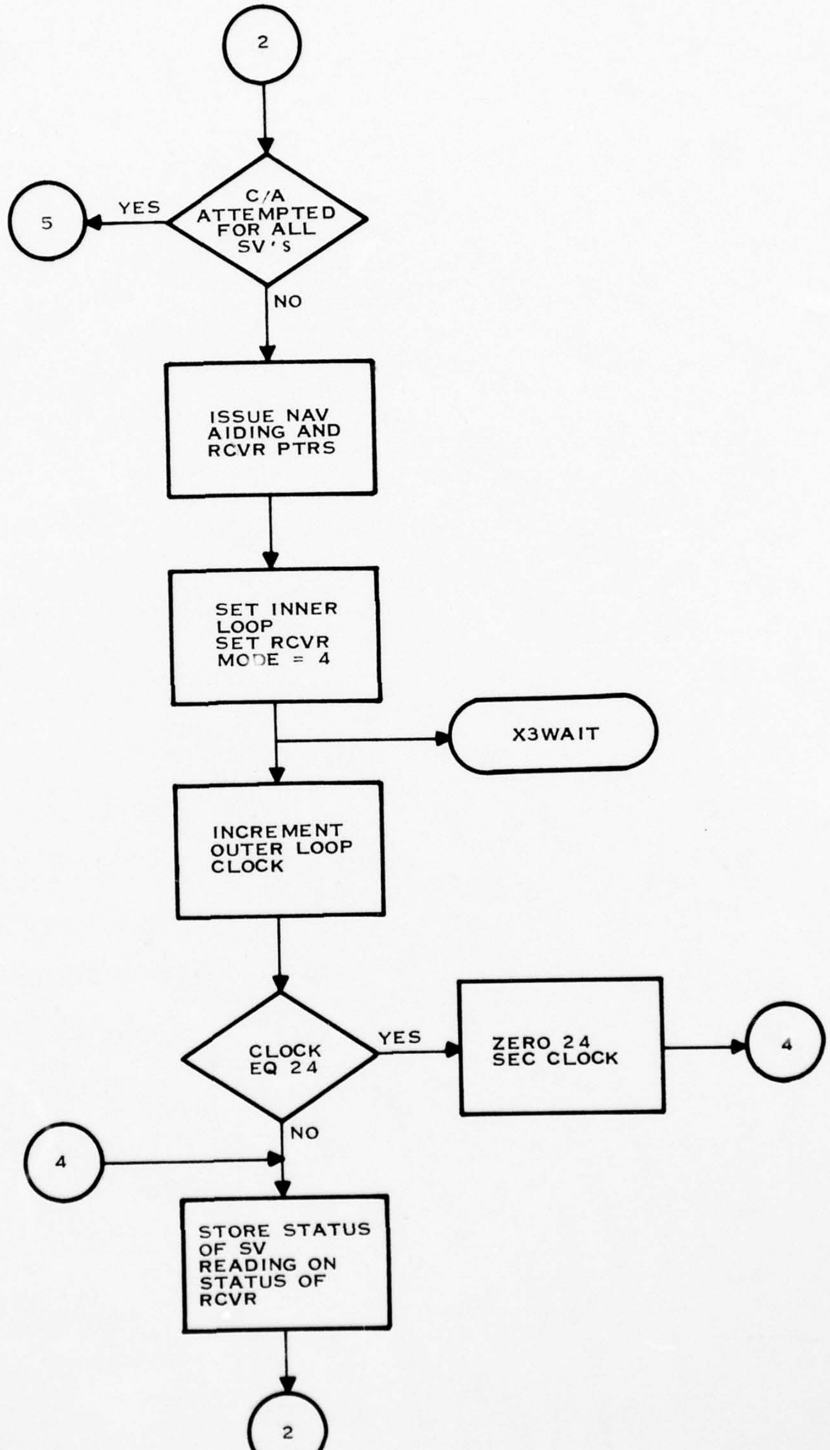
APPENDIX C

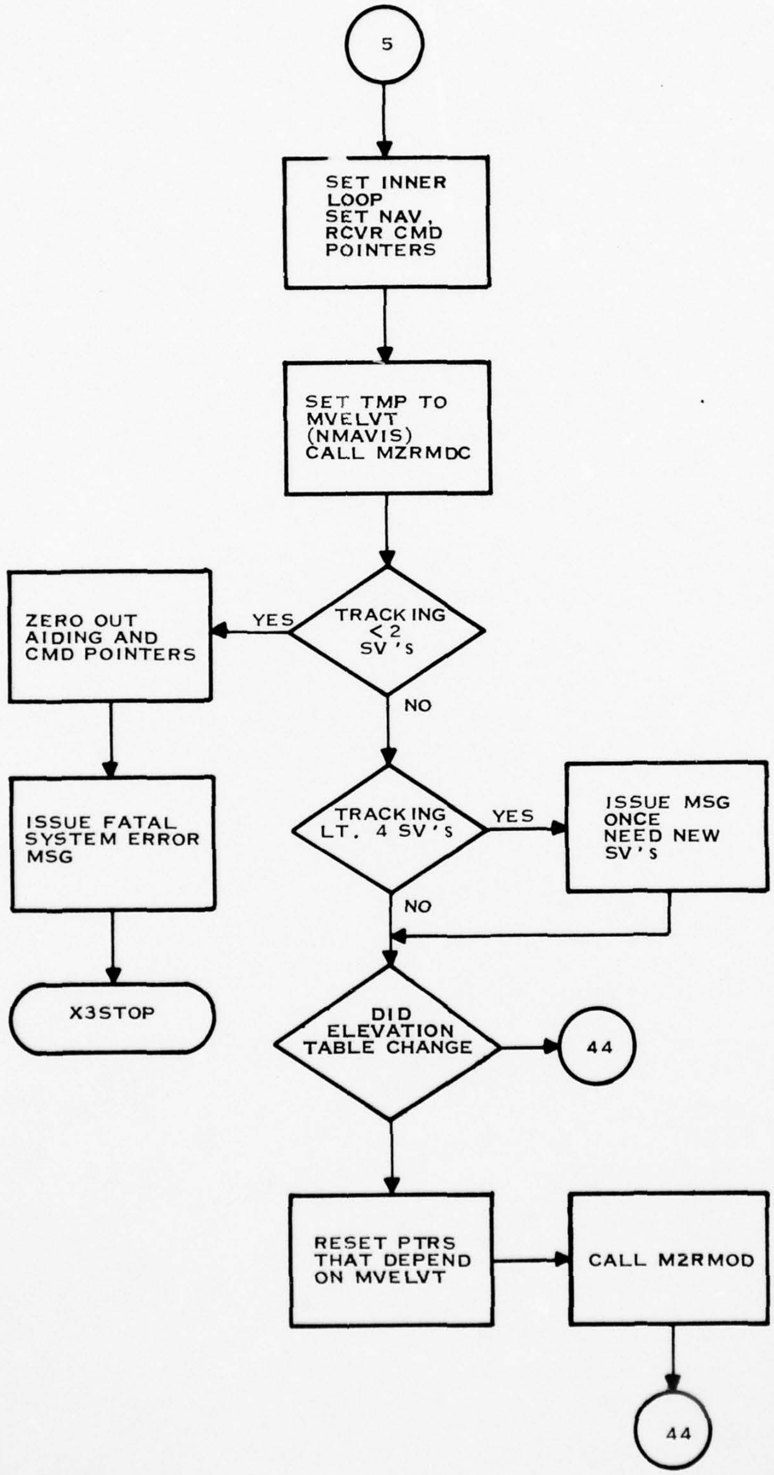
SELECTED MASTER CONTROL MODULE FLOWCHARTS

This section contains flowcharts for certain Master Control modules which perform the control and interface tasks for the Receiver and Navigation subsystems. The flowcharts which follow are:

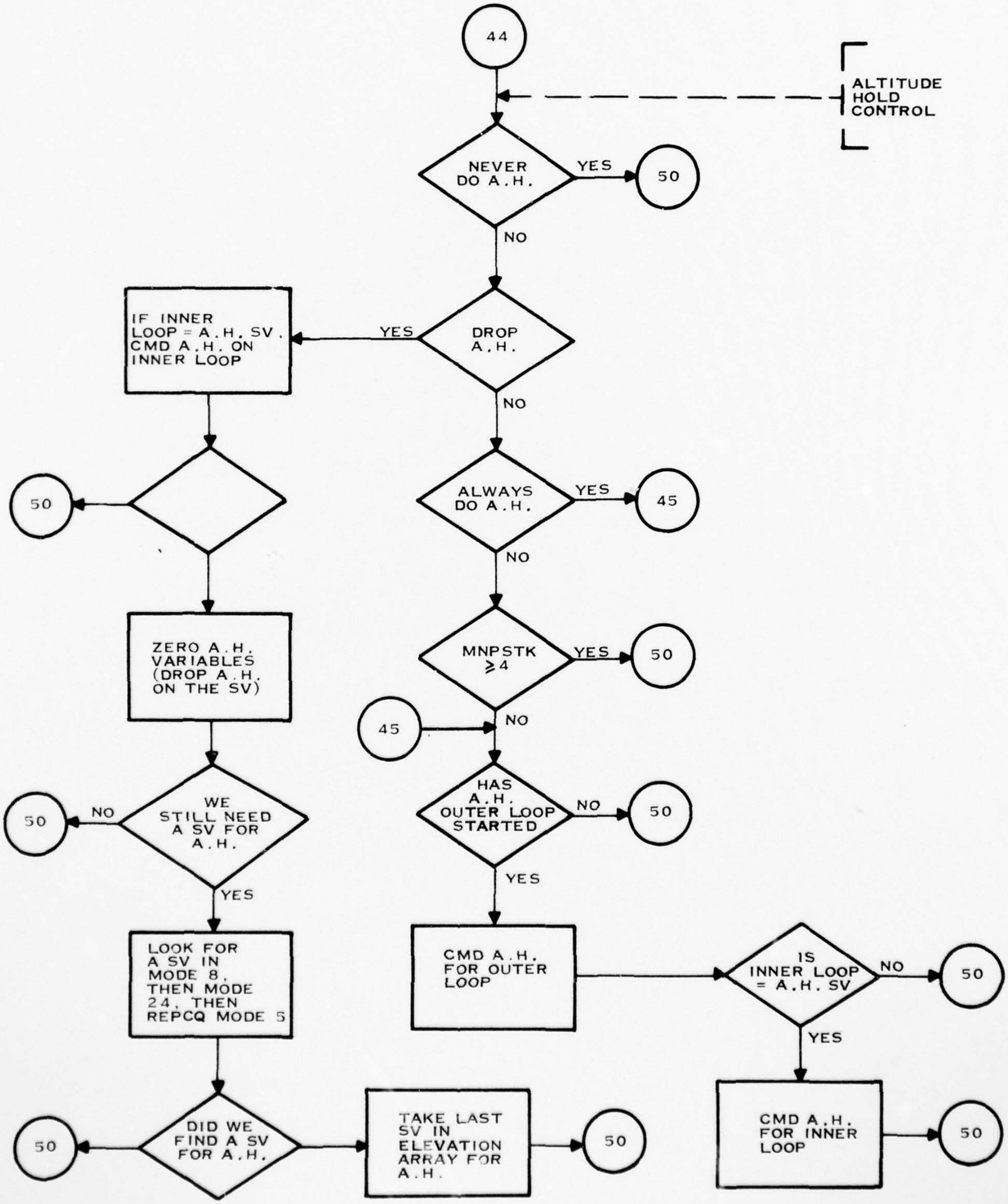

MINSVC
INITIAL-
ZATION
C/A REACQ
X3WAIT
ALL SV'S PROCESSED
NO
YES
1
P-REACQ
RCVR HEALTH AND MODE CTL
A
A
ALL SV'S PROCESSED
NO
SELECT NEXT SV
X3WAIT
1
YES
LT 6 SV'S
YES
SCHEDULE NEW SV ACQUISITION
NO
START WITH 1ST SV
1

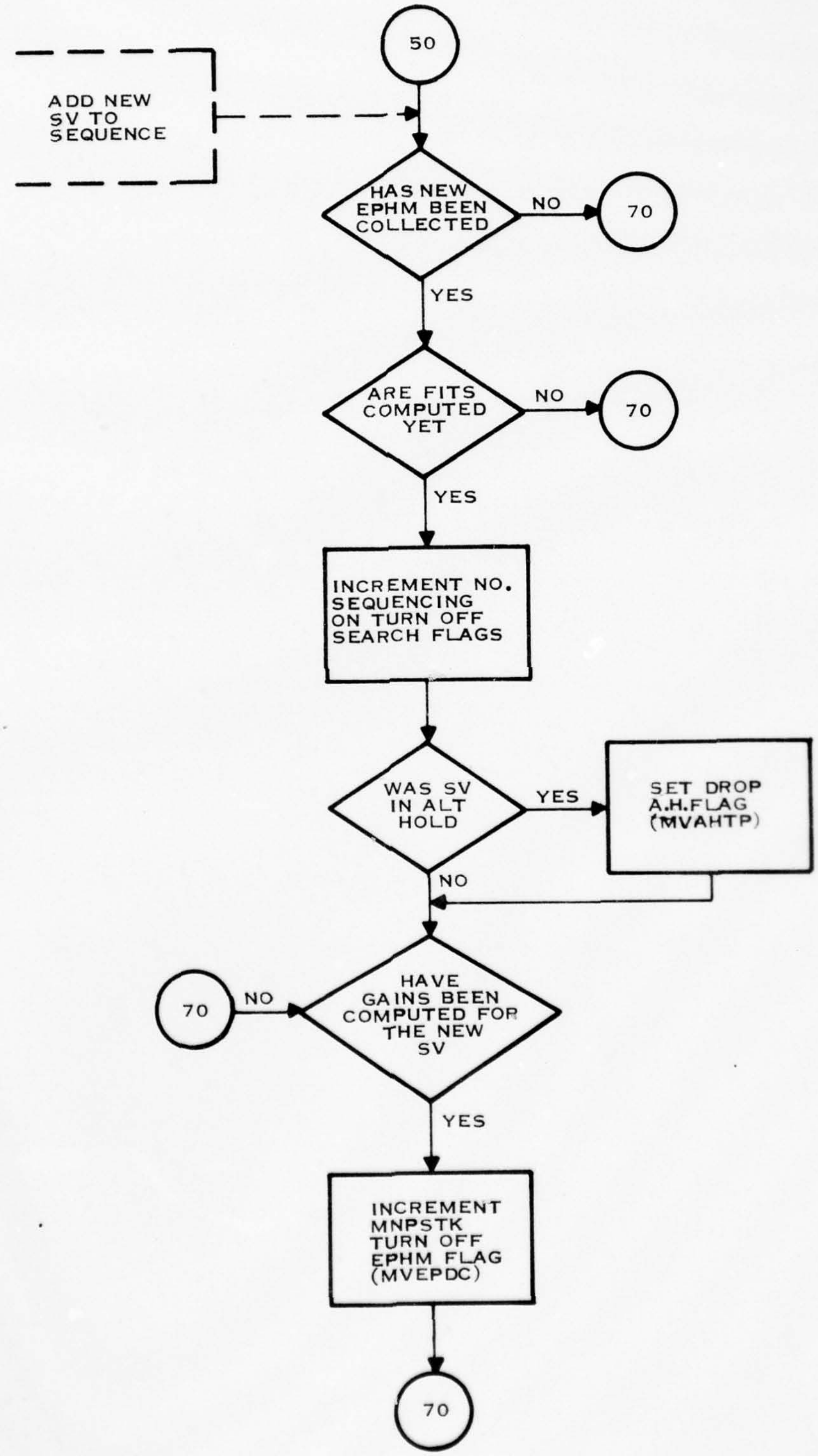

MINSVC
X3ACT (MICNSV) X3ACT (MONST2) X3ACT (N1MNFL)
INITIALIZE FLAGS FOR WARM AND COLD START
INITIALIZE PRIOR TWO RCVR MODES
REARRANGE MVELVT FOR SV NOT ACQUIRED
ASSIGN INITIAL MCSTAT'S FOR SV'S NOT ATTEMPTED
SELECT INITIAL A.H. SV IF ONLY 3 ARE ACQUIRED
2


2
C/A ATTEMPTED FOR ALL SV'S
YES
5
NO
ISSUE NAV AIDING AND RCVR PTRS
SET INNER LOOP
SET RCVR MODE = 4
X3WAIT
INCREMENT OUTER LOOP CLOCK
CLOCK EQ 24
YES
ZERO 24 SEC CLOCK
4
NO
4
STORE STATUS OF SV READING ON STATUS OF RCVR
2



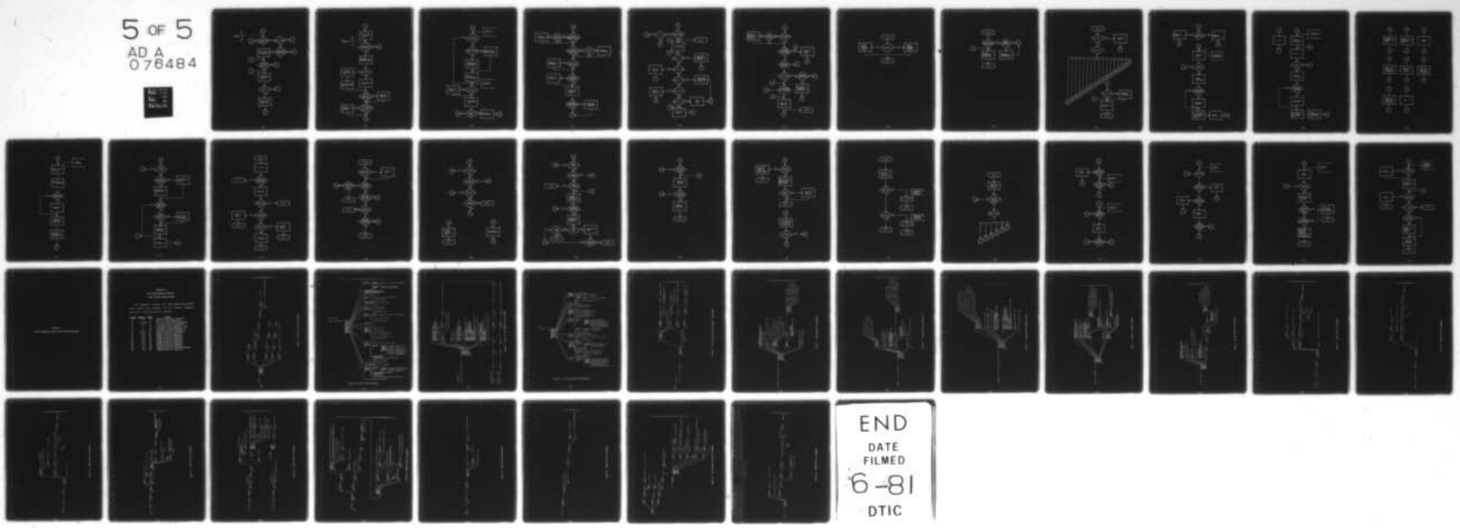
5
SET INNER LOOP SET NAV, RCVR CMD POINTERS
SET TMP TO MVELVT (NMAVIS) CALL MZRMDC
TRACKING < 2 SV'S
YES
NO
ZERO OUT AIDING AND CMD POINTERS
ISSUE FATAL SYSTEM ERROR MSG
X3STOP
TRACKING LT. 4 SV'S
YES
NO
ISSUE MSG ONCE NEED NEW SV'S
DID ELEVATION TABLE CHANGE
44
RESET PTRS THAT DEPEND ON MVELVT
CALL M2RMOD
44


44
ALTITUDE HOLD CONTROL
NEVER DO A.H.
YES
50
NO
DROP A.H.
YES
IF INNER LOOP = A.H. SV. CMD A.H. ON INNER LOOP
NO
50
ALWAYS DO A.H.
YES
45
NO
ZERO A.H. VARIABLES (DROP A.H. ON THE SV)
MNPSTK ≥4
YES
50
45
NO
HAS A.H. OUTER LOOP STARTED
NO
50
50
NO
WE STILL NEED A SV FOR A.H.
YES
YES
LOOK FOR A SV IN MODE 8, THEN MODE 24, THEN REPCQ MODE 5
CMD A.H. FOR OUTER LOOP
IS INNER LOOP = A.H. SV
NO
50
YES
50
DID WE FIND A SV FOR A.H.
TAKE LAST SV IN ELEVATION ARRAY FOR A.H.
50
CMD A.H. FOR INNER LOOP
50


50
ADD NEW SV TO SEQUENCE
HAS NEW EPHM BEEN COLLECTED
NO
70
YES
ARE FITS COMPUTED YET
NO
70
YES
INCREMENT NO. SEQUENCING ON TURN OFF SEARCH FLAGS
WAS SV IN ALT HOLD
YES
SET DROP A.H.FLAG (MVAHTP)
NO
70
NO
HAVE GAINS BEEN COMPUTED FOR THE NEW SV
YES
INCREMENT MNPSTK TURN OFF EPHM FLAG (MVEPDC)
70

AD-A076 484 TEXAS INSTRUMENTS INC DALLAS EQUIPMENT GROUP F/G 17/7
GLOBAL POSITIONING SYSTEM (GPS). MANPACK/VEHICULAR USER EQUIPME--ETC(U)
AUG 79 F04701-75-C-0181
UNCLASSIFIED SAMSO-SD-TR-79-13-VOL-3 NL

5 OF 5
AD A
076484



END
DATE
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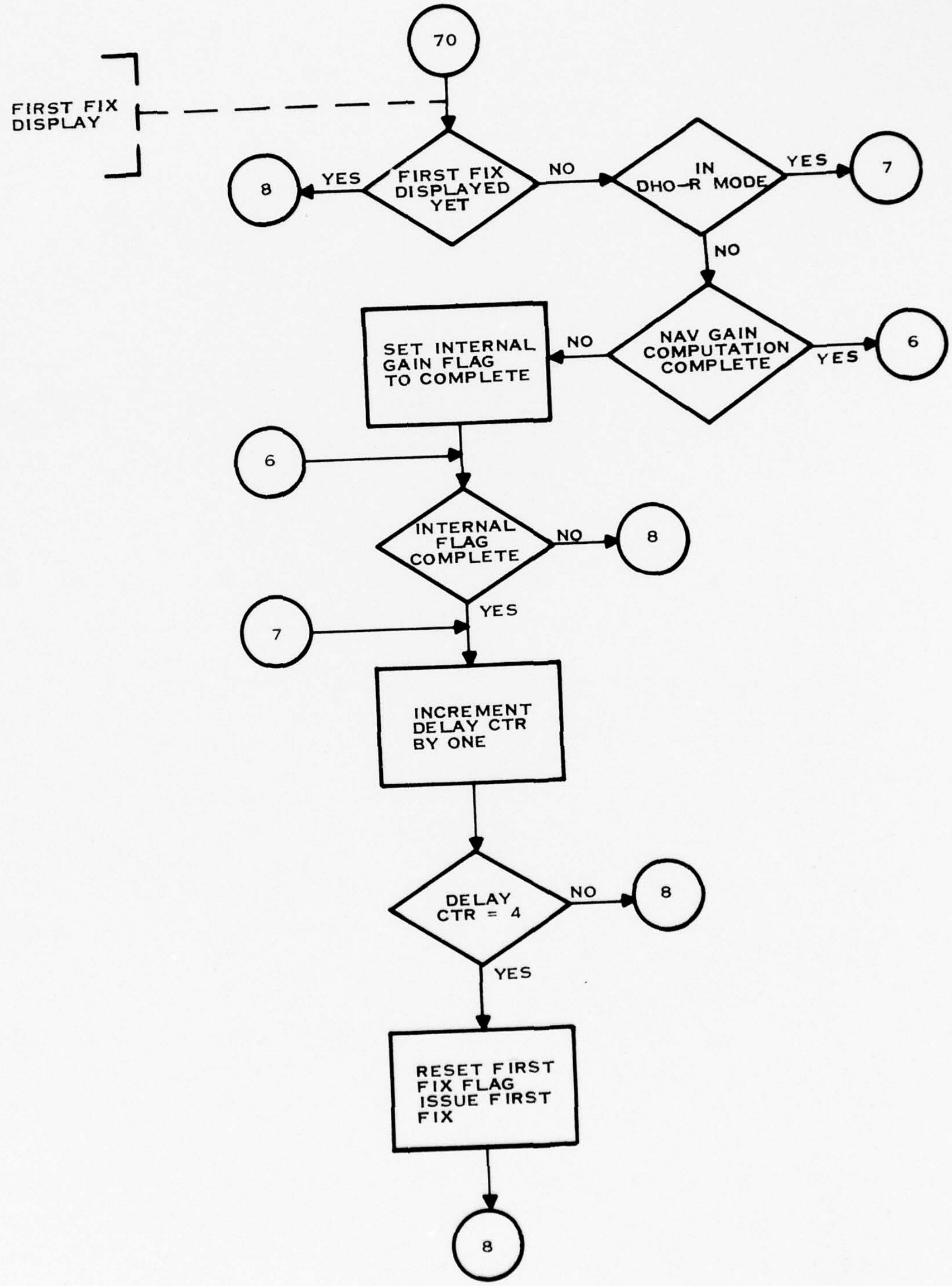
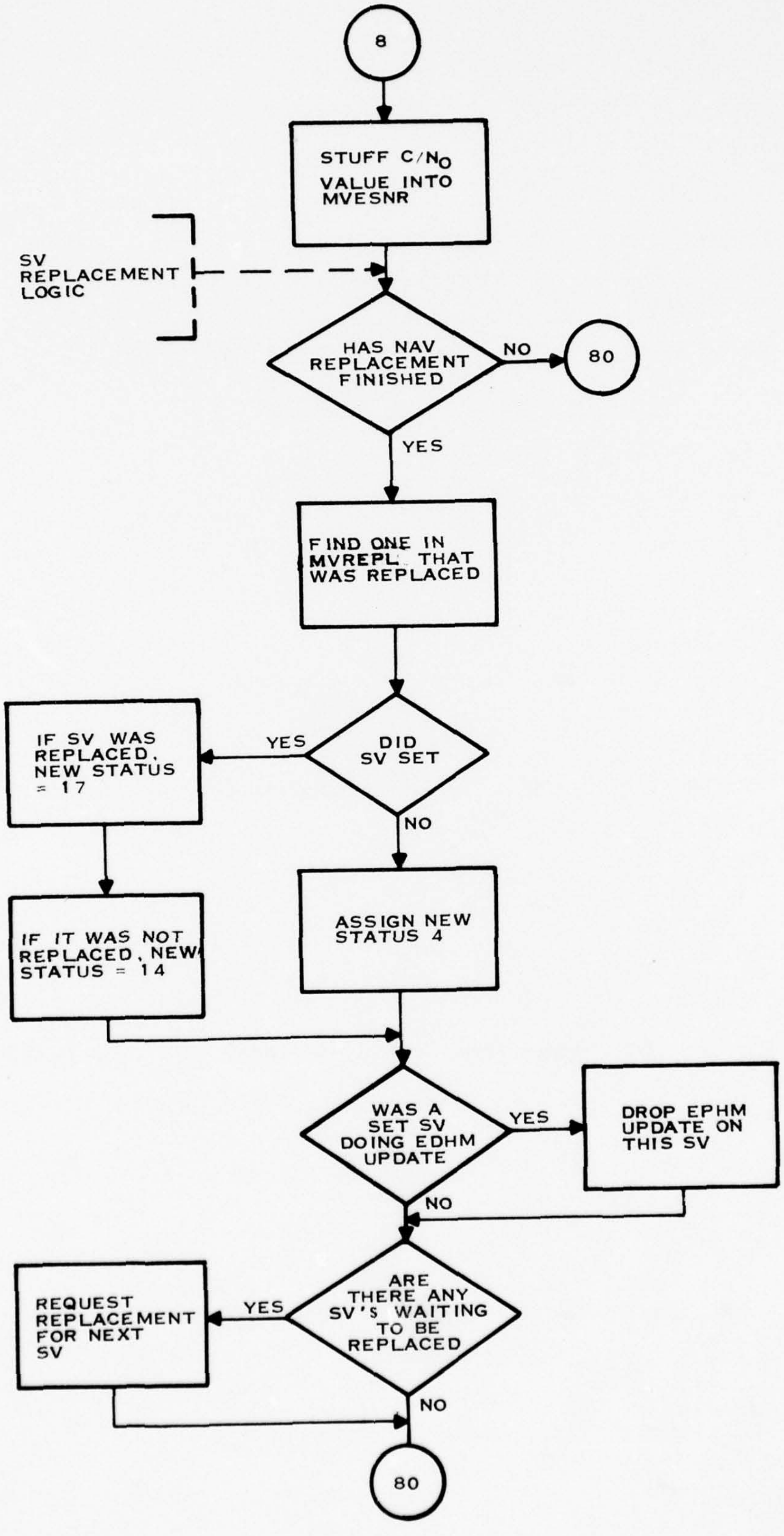
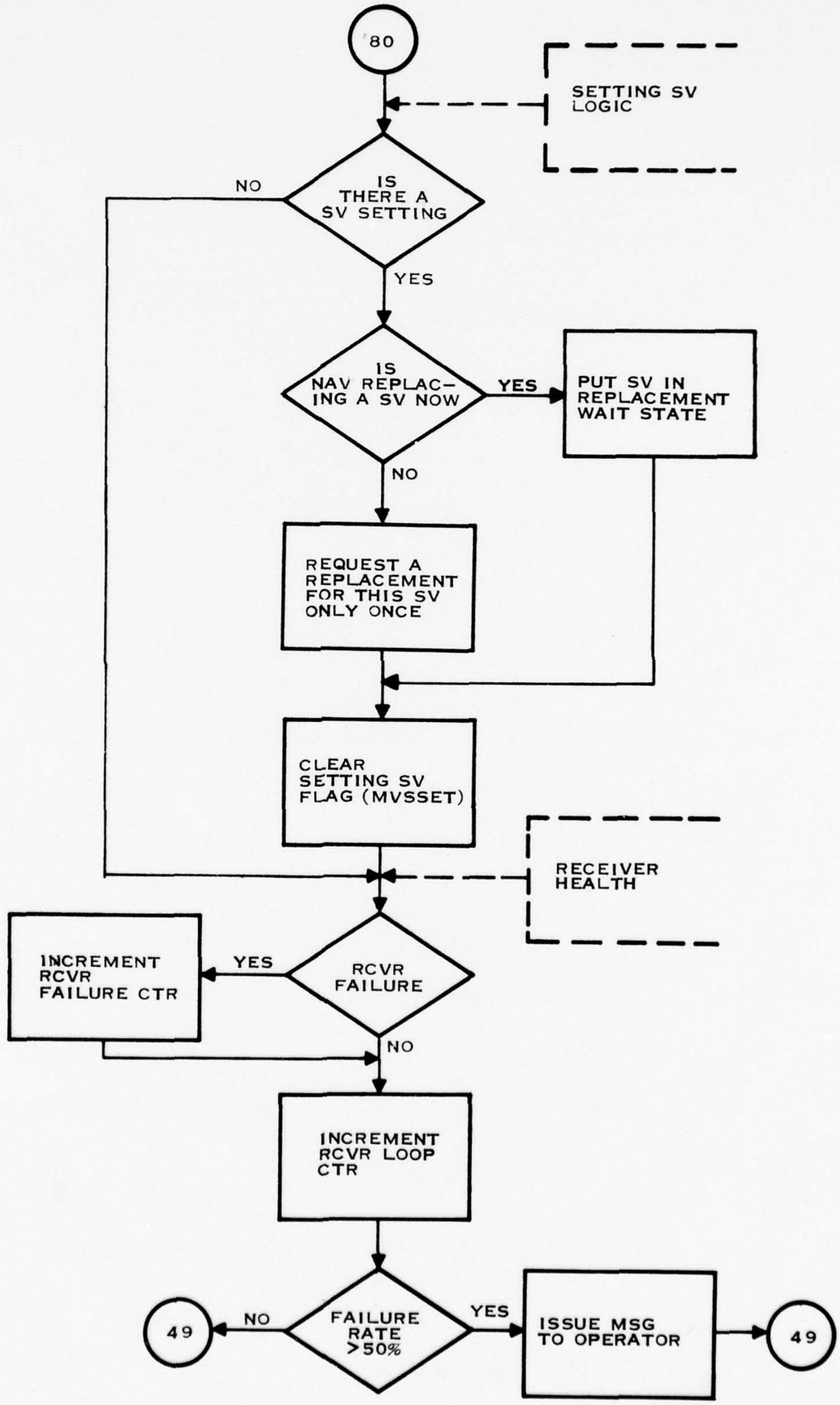
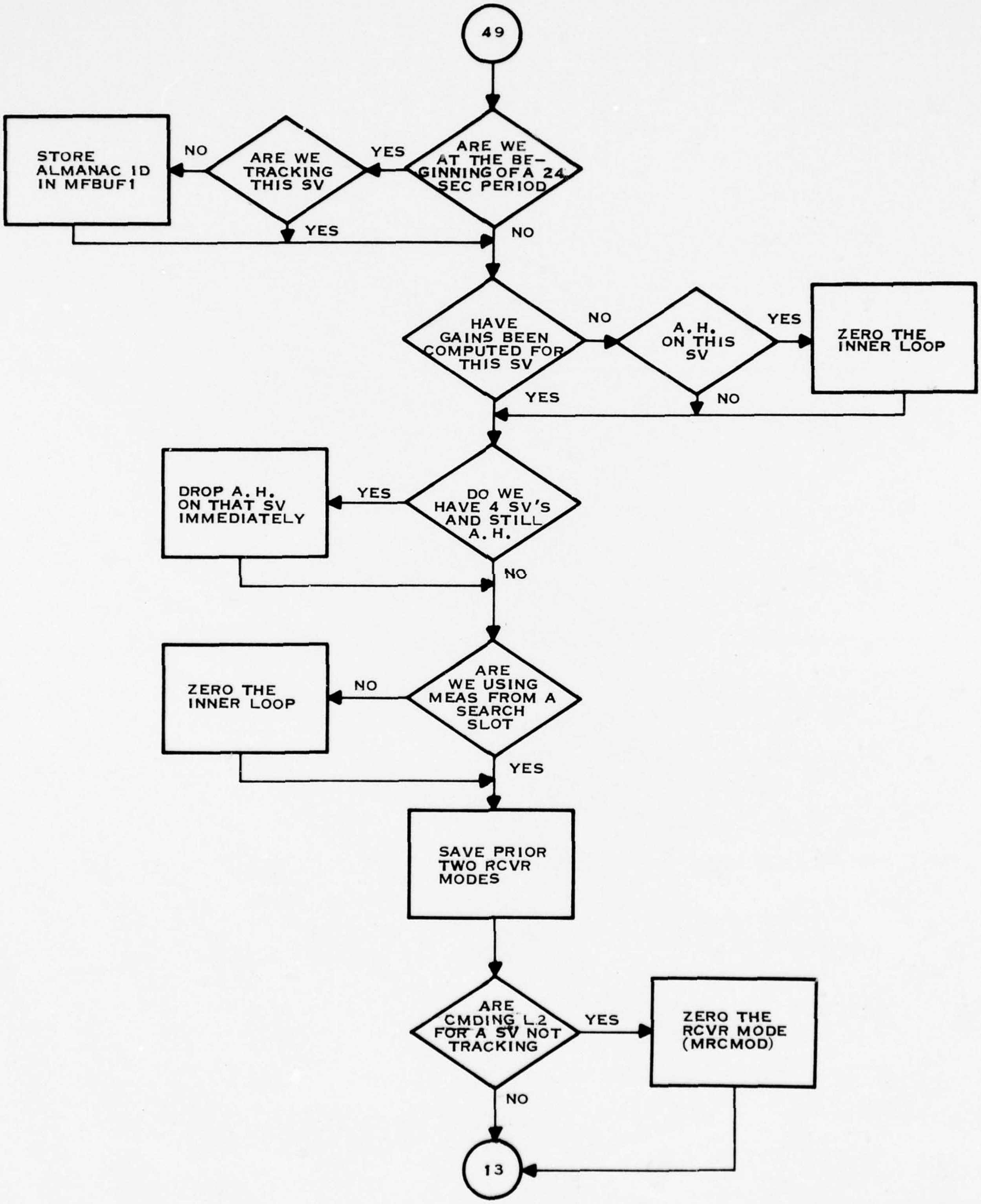
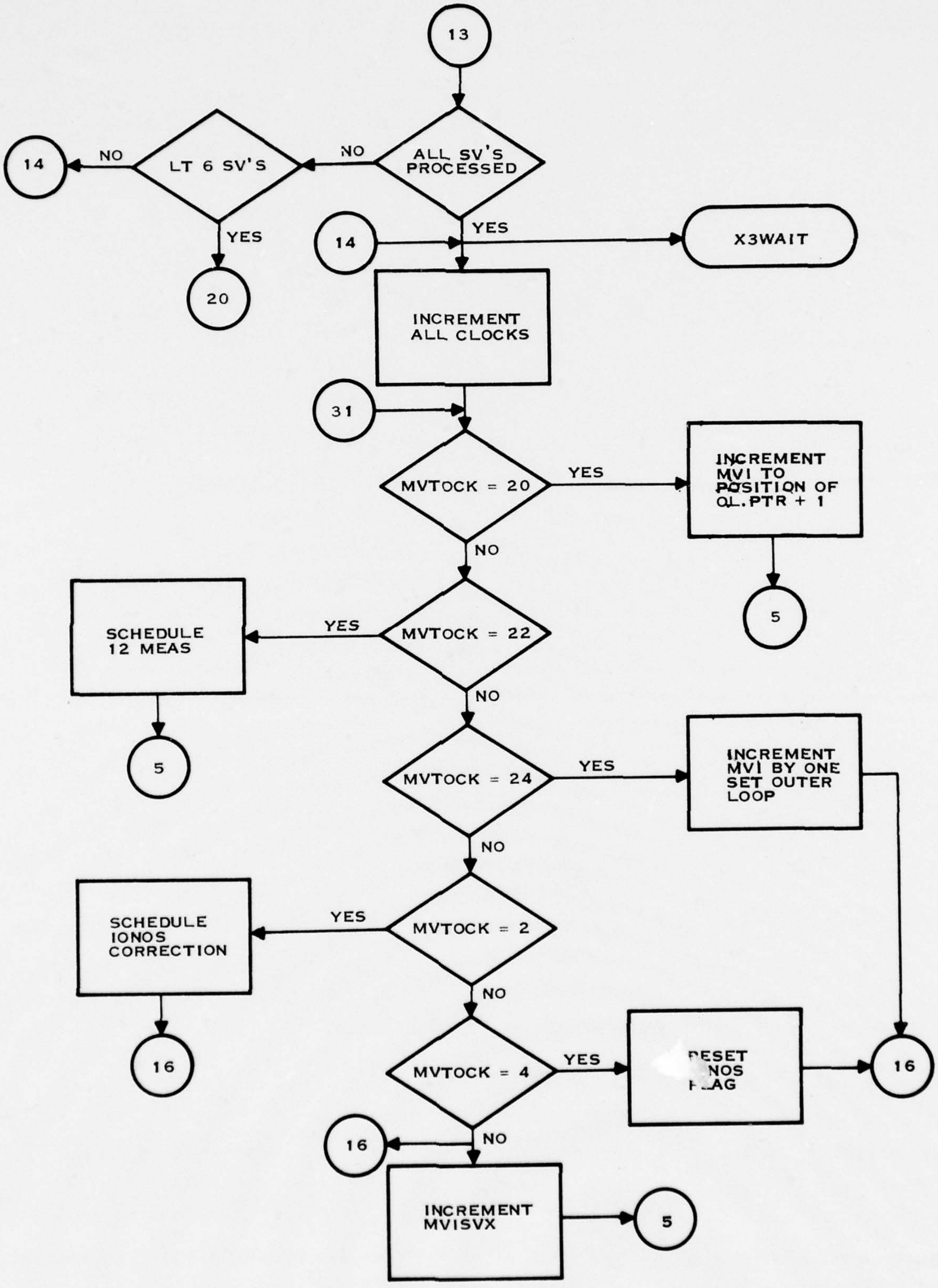
6-81
DTIC

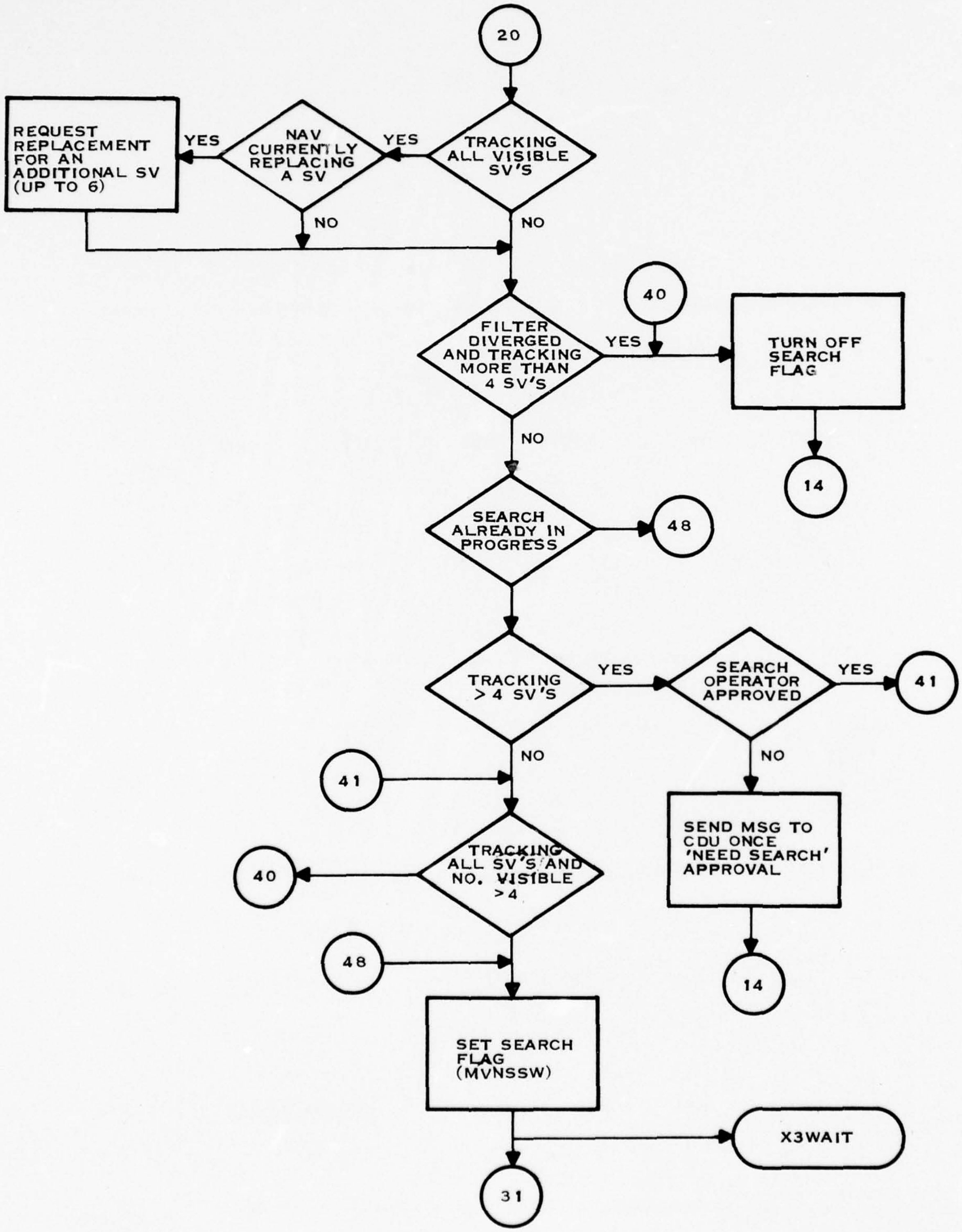

70
FIRST FIX DISPLAY
FIRST FIX DISPLAYED YET
YES
NO
8
IN DHO-R MODE
YES
7
NO
NAV GAIN COMPUTATION COMPLETE
NO
YES
6
SET INTERNAL GAIN FLAG TO COMPLETE
6
INTERNAL FLAG COMPLETE
NO
8
YES
7
INCREMENT DELAY CTR BY ONE
DELAY CTR = 4
NO
8
YES
RESET FIRST FIX FLAG ISSUE FIRST FIX
8

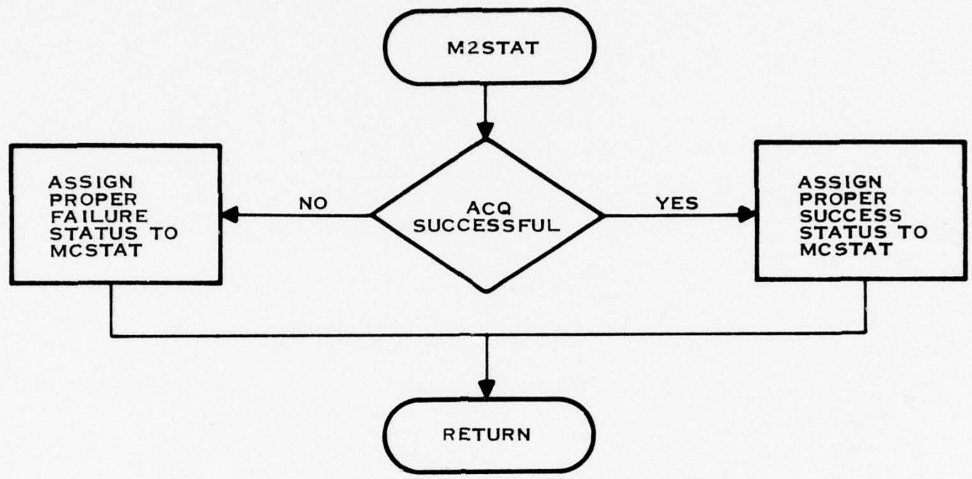

8
STUFF C/N$_O$ VALUE INTO MVESNR
SV REPLACEMENT LOGIC
HAS NAV REPLACEMENT FINISHED
NO
80
YES
FIND ONE IN MVREPL THAT WAS REPLACED
DID SV SET
YES
IF SV WAS REPLACED, NEW STATUS = 17
IF IT WAS NOT REPLACED, NEW STATUS = 14
NO
ASSIGN NEW STATUS 4
WAS A SET SV DOING EDHM UPDATE
YES
DROP EPHM UPDATE ON THIS SV
NO
ARE THERE ANY SV'S WAITING TO BE REPLACED
YES
REQUEST REPLACEMENT FOR NEXT SV
NO
80

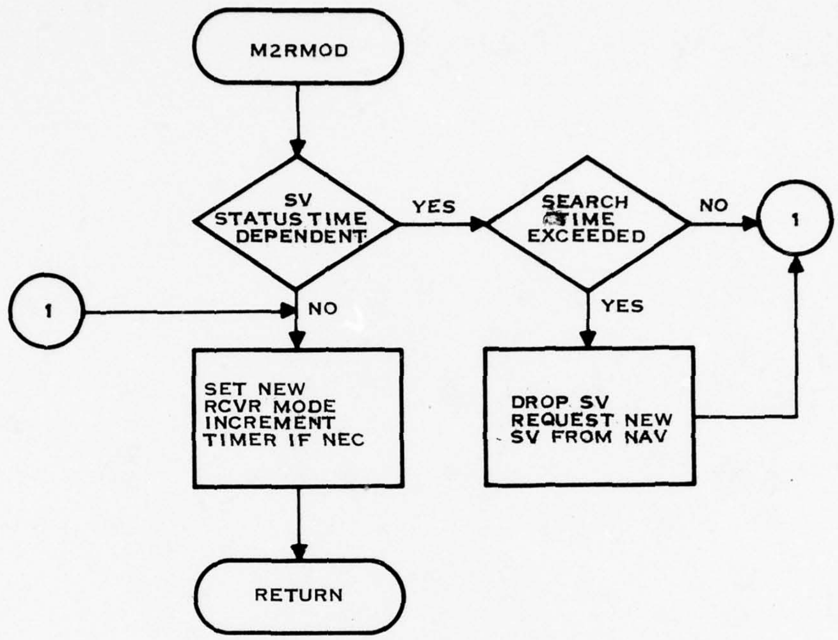

80
SETTING SV LOGIC
IS THERE A SV SETTING
NO
YES
IS NAV REPLACING A SV NOW
YES
PUT SV IN REPLACEMENT WAIT STATE
NO
REQUEST A REPLACEMENT FOR THIS SV ONLY ONCE
CLEAR SETTING SV FLAG (MVSSET)
RECEIVER HEALTH
INCREMENT RCVR FAILURE CTR
YES
RCVR FAILURE
NO
INCREMENT RCVR LOOP CTR
49
NO
FAILURE RATE >50%
YES
ISSUE MSG TO OPERATOR
49

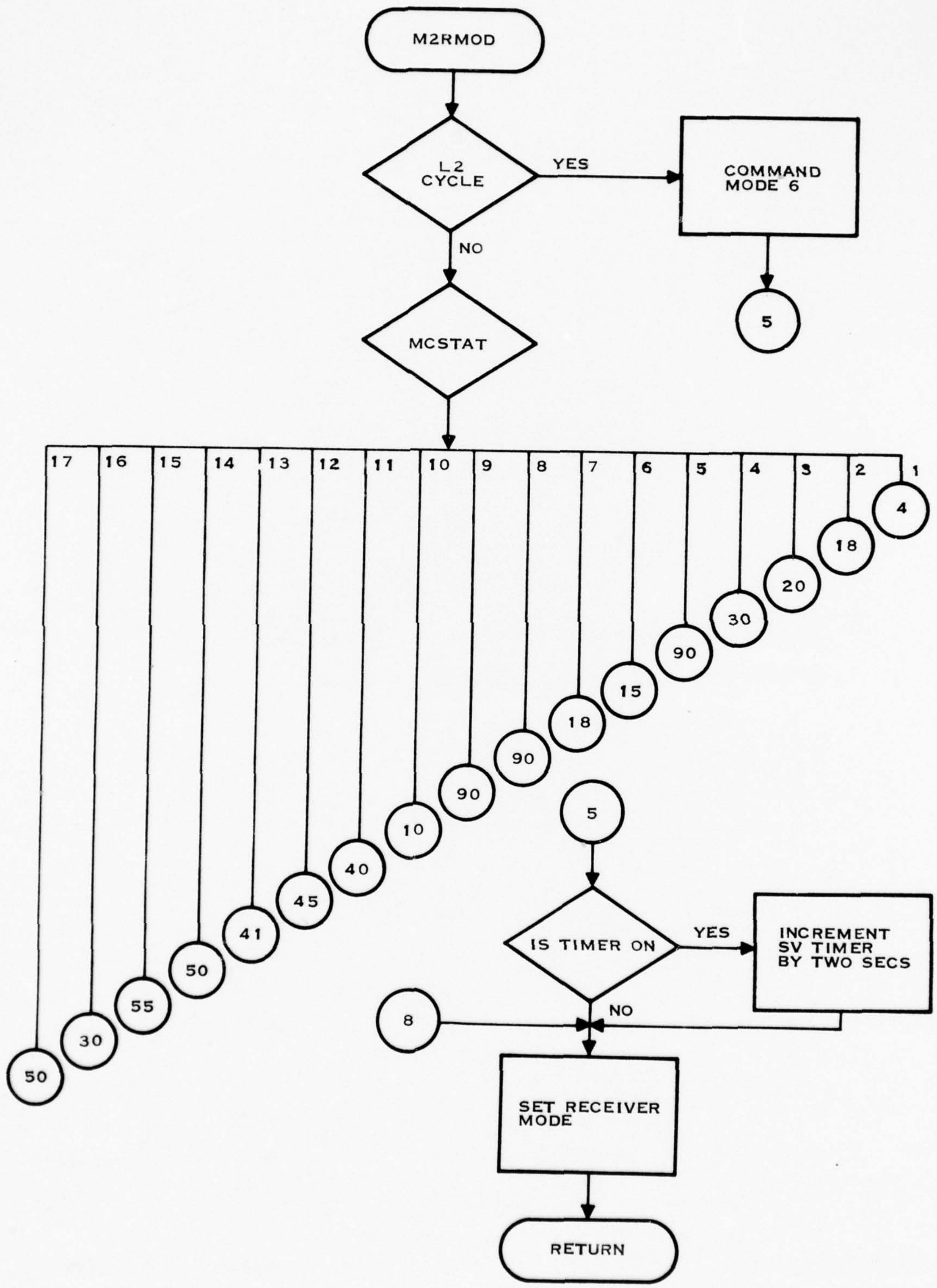

49
ARE WE AT THE BEGINNING OF A 24 SEC PERIOD
YES
ARE WE TRACKING THIS SV
NO
STORE ALMANAC ID IN MFBUF1
YES
NO
HAVE GAINS BEEN COMPUTED FOR THIS SV
NO
A. H. ON THIS SV
YES
ZERO THE INNER LOOP
NO
YES
DO WE HAVE 4 SV'S AND STILL A. H.
YES
DROP A. H. ON THAT SV IMMEDIATELY
NO
ARE WE USING MEAS FROM A SEARCH SLOT
NO
ZERO THE INNER LOOP
YES
SAVE PRIOR TWO RCVR MODES
ARE CMDING L2 FOR A SV NOT TRACKING
YES
ZERO THE RCVR MODE (MRCMOD)
NO
13

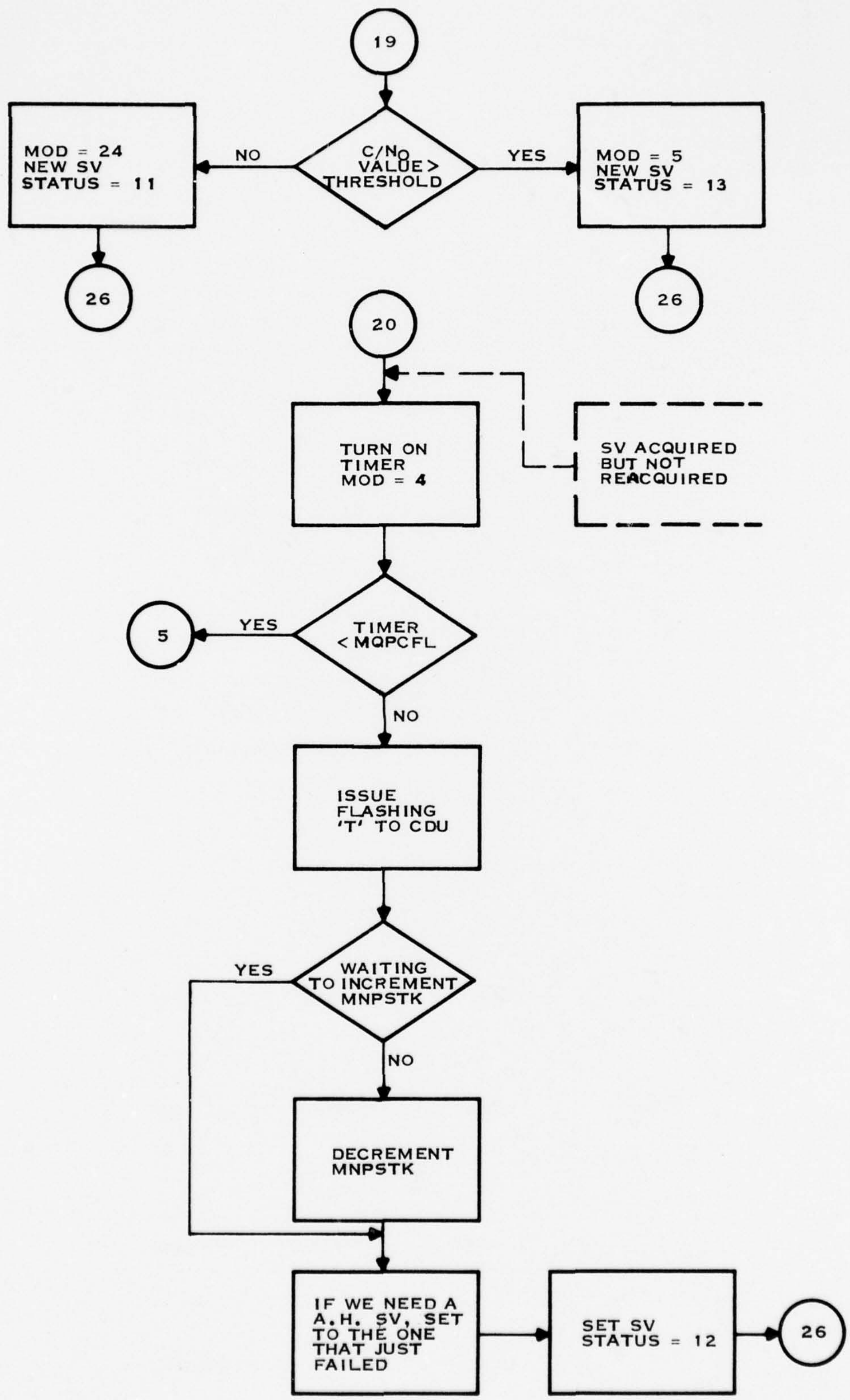

13
ALL SV'S PROCESSED
NO
LT 6 SV'S
NO
14
YES
20
YES
14
X3WAIT
INCREMENT ALL CLOCKS
31
MVTOCK = 20
YES
INCREMENT MVI TO POSITION OF OL.PTR + 1
5
NO
MVTOCK = 22
YES
SCHEDULE 12 MEAS
5
NO
MVTOCK = 24
YES
INCREMENT MVI BY ONE SET OUTER LOOP
NO
MVTOCK = 2
YES
SCHEDULE IONOS CORRECTION
16
NO
MVTOCK = 4
YES
RESET IONOS FLAG
16
NO
16
INCREMENT MVISVX
5

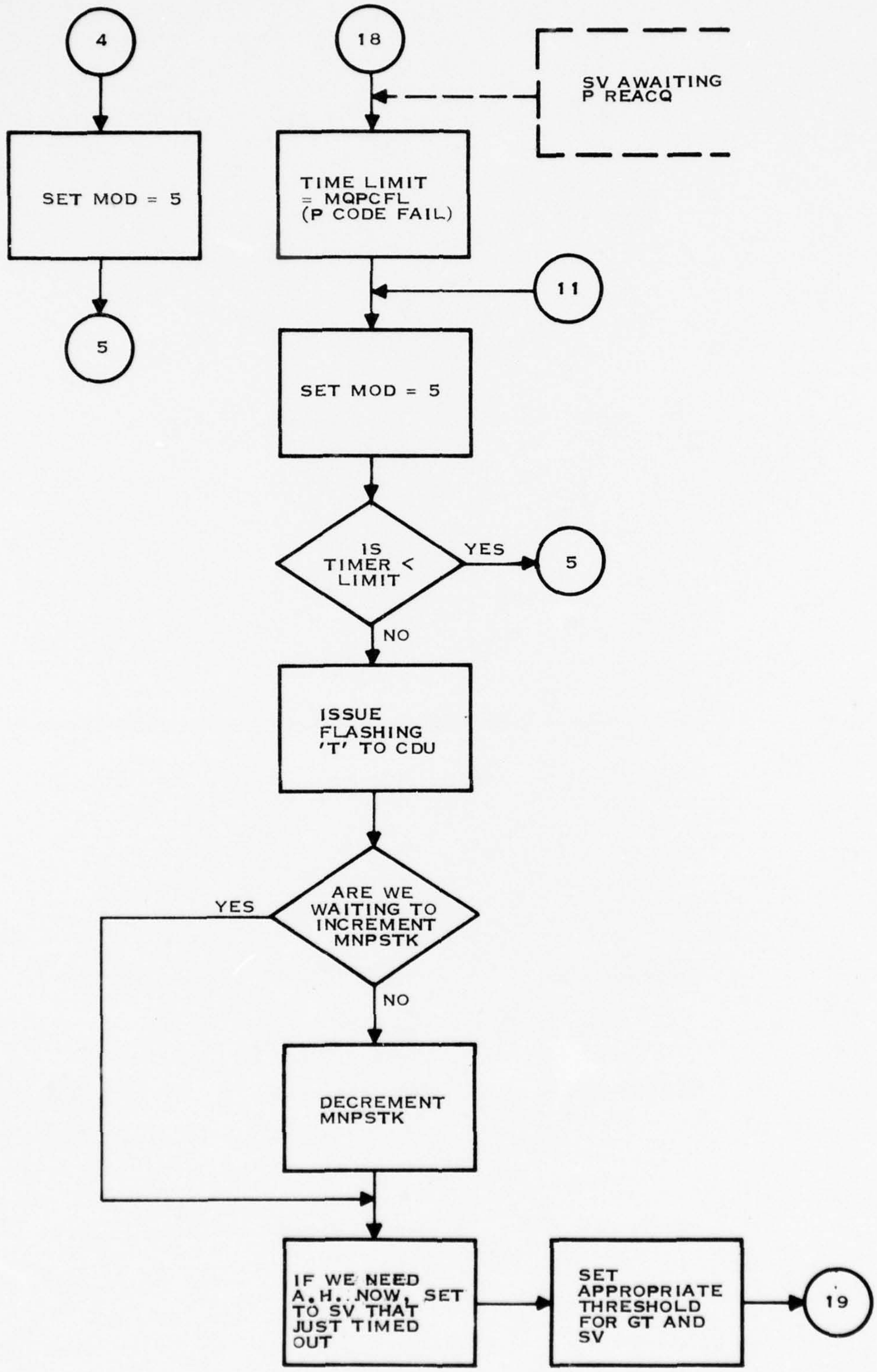

20
TRACKING ALL VISIBLE SV'S
YES
NAV CURRENTLY REPLACING A SV
YES
REQUEST REPLACEMENT FOR AN ADDITIONAL SV (UP TO 6)
NO
NO
FILTER DIVERGED AND TRACKING MORE THAN 4 SV'S
YES
40
TURN OFF SEARCH FLAG
14
NO
SEARCH ALREADY IN PROGRESS
48
TRACKING > 4 SV'S
YES
SEARCH OPERATOR APPROVED
YES
41
NO
NO
41
SEND MSG TO CDU ONCE 'NEED SEARCH' APPROVAL
14
TRACKING ALL SV'S AND NO. VISIBLE > 4
40
48
SET SEARCH FLAG (MVNSSW)
X3WAIT
31


M2STAT
ACQ SUCCESSFUL
NO
YES
ASSIGN PROPER FAILURE STATUS TO MCSTAT
ASSIGN PROPER SUCCESS STATUS TO MCSTAT
RETURN

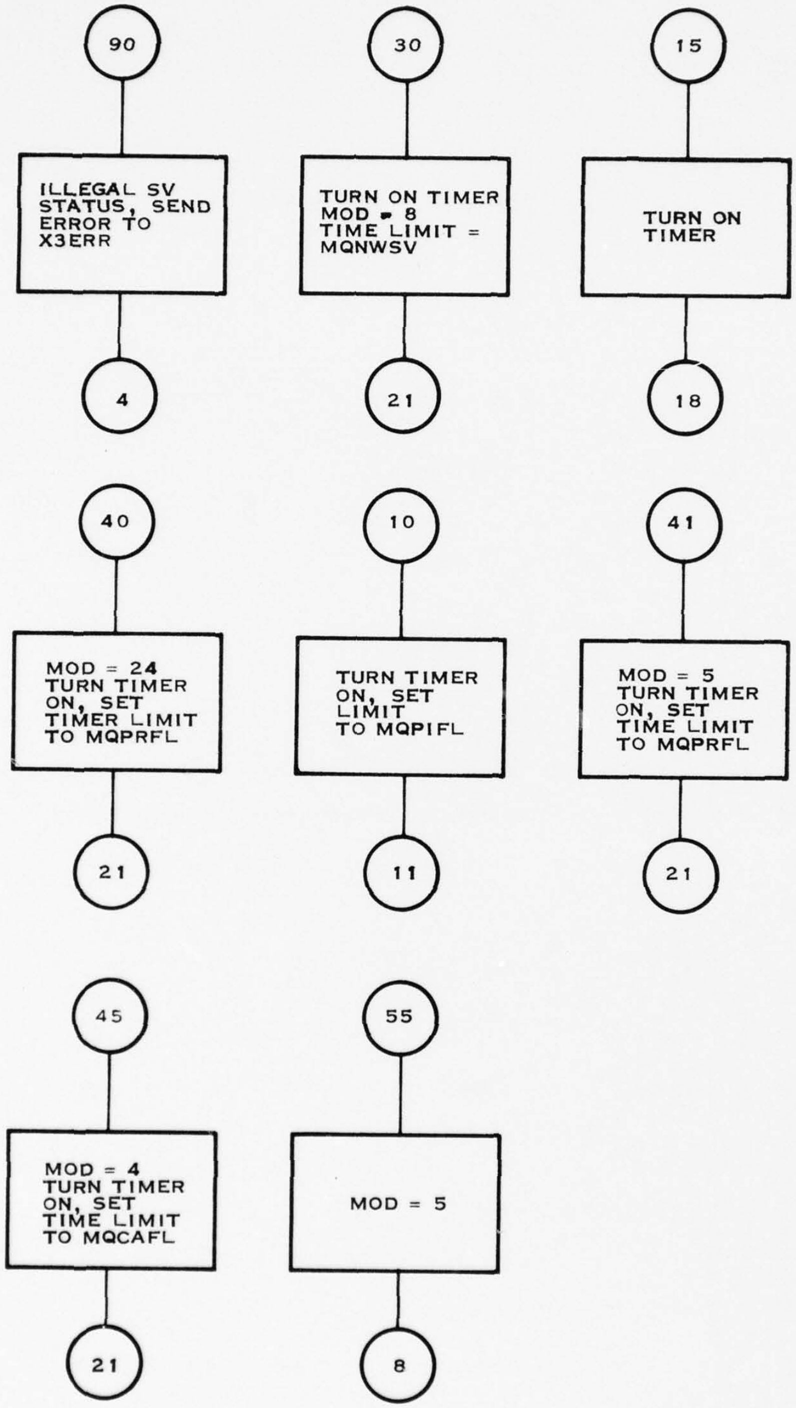

M2RMOD
SV STATUS TIME DEPENDENT
YES
SEARCH TIME EXCEEDED
NO
1
1
NO
YES
SET NEW RCVR MODE INCREMENT TIMER IF NEC
DROP SV REQUEST NEW SV FROM NAV
RETURN

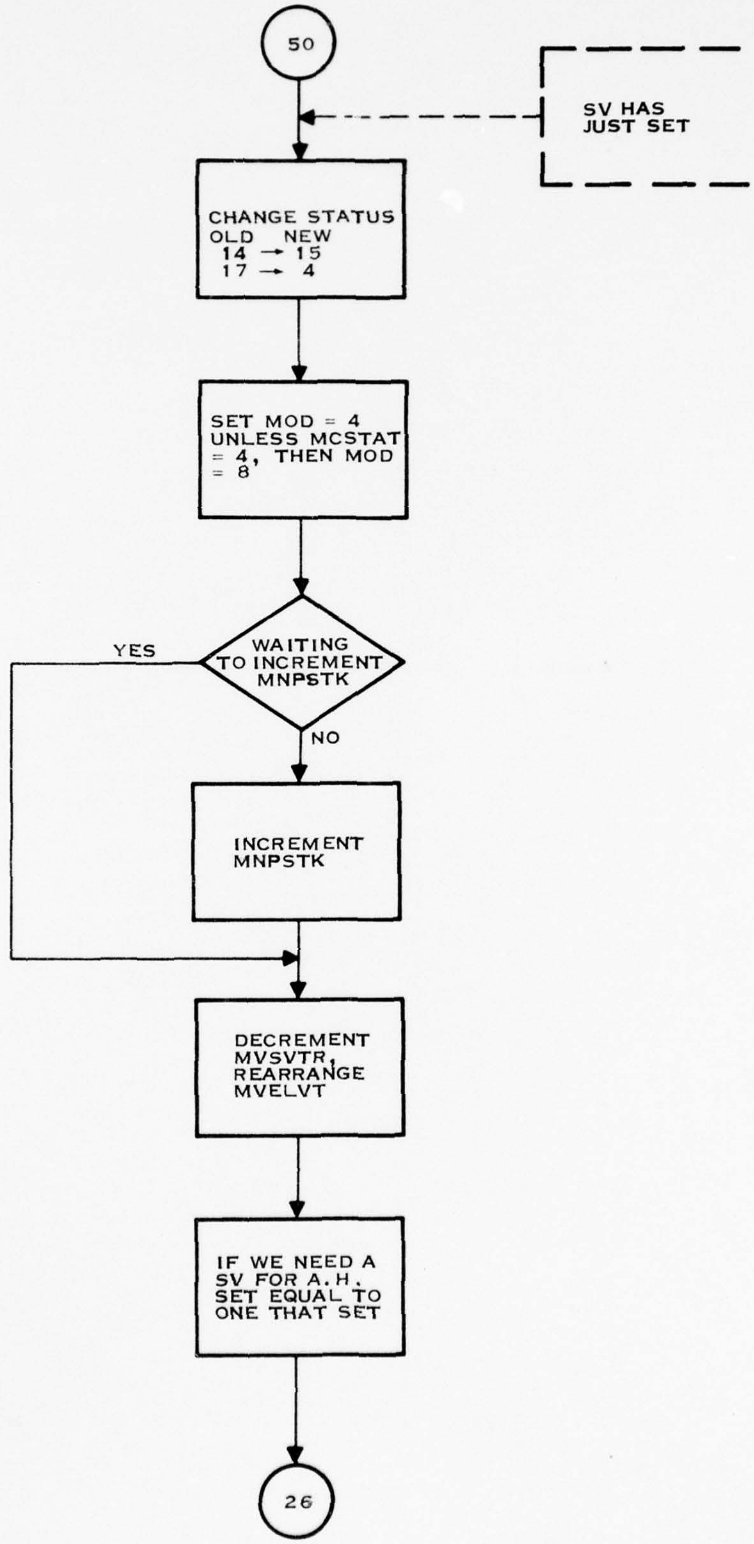

M2RMOD
L2 CYCLE
YES
COMMAND MODE 6
5
NO
MCSTAT
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
4
18
20
30
90
15
18
90
90
10
40
45
41
50
55
30
50
5
IS TIMER ON
YES
INCREMENT SV TIMER BY TWO SECS
NO
8
SET RECEIVER MODE
RETURN

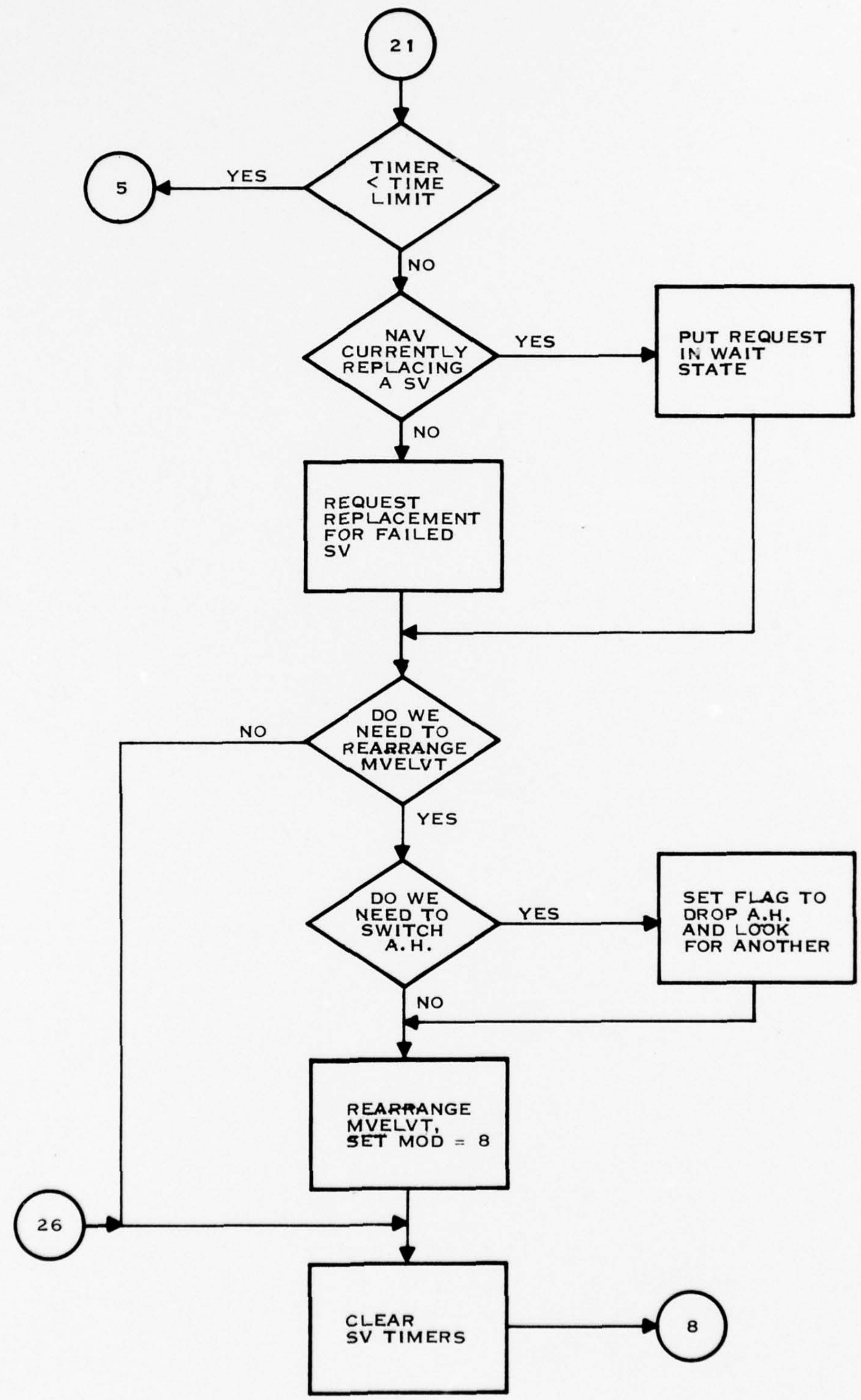

19
C/No VALUE > THRESHOLD
NO
YES
MOD = 24 NEW SV STATUS = 11
MOD = 5 NEW SV STATUS = 13
26
26
20
TURN ON TIMER MOD = 4
SV ACQUIRED BUT NOT REACQUIRED
TIMER < MQPCFL
YES
5
NO
ISSUE FLASHING 'T' TO CDU
WAITING TO INCREMENT MNPSTK
YES
NO
DECREMENT MNPSTK
IF WE NEED A A.H. SV, SET TO THE ONE THAT JUST FAILED
SET SV STATUS = 12
26

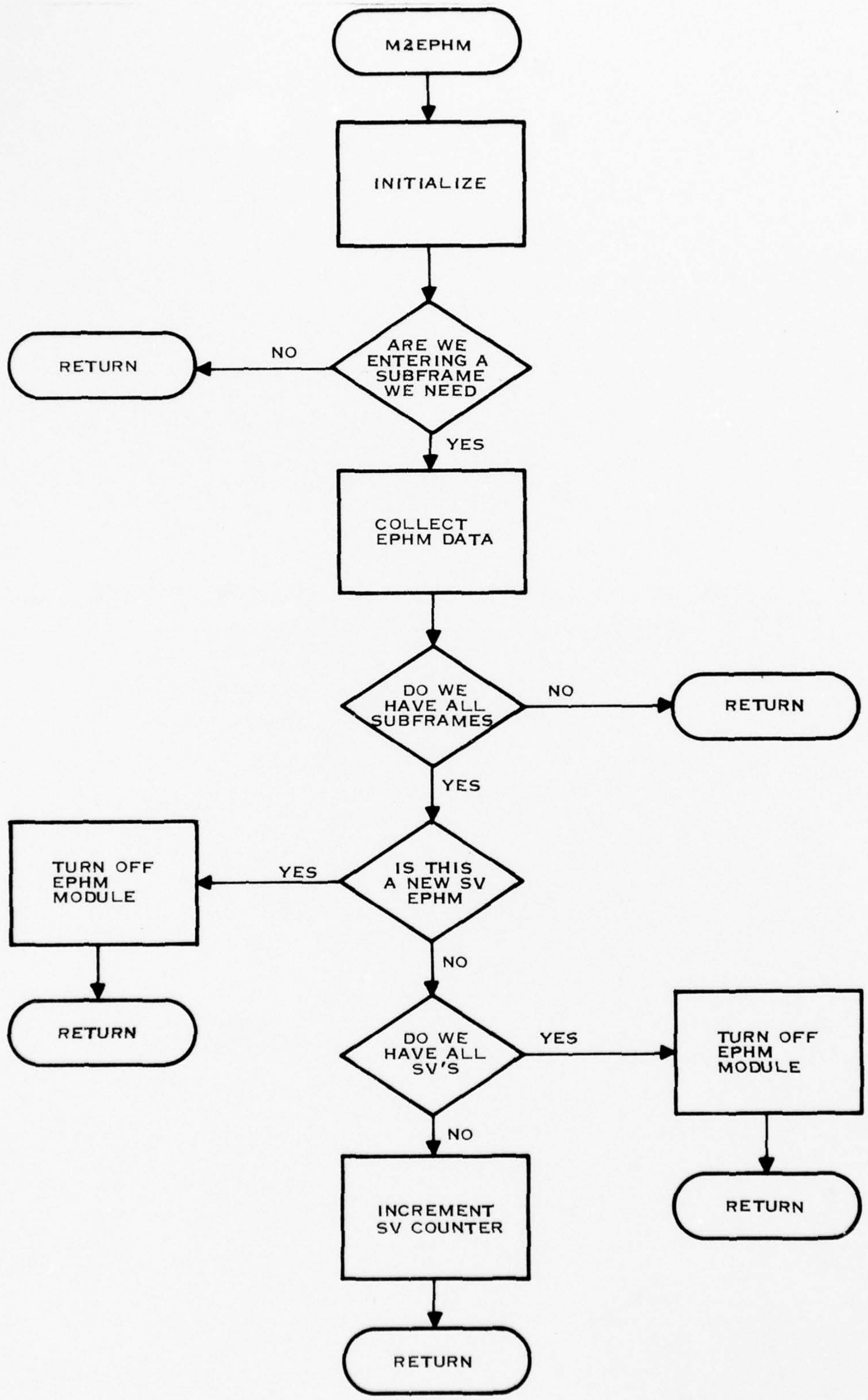


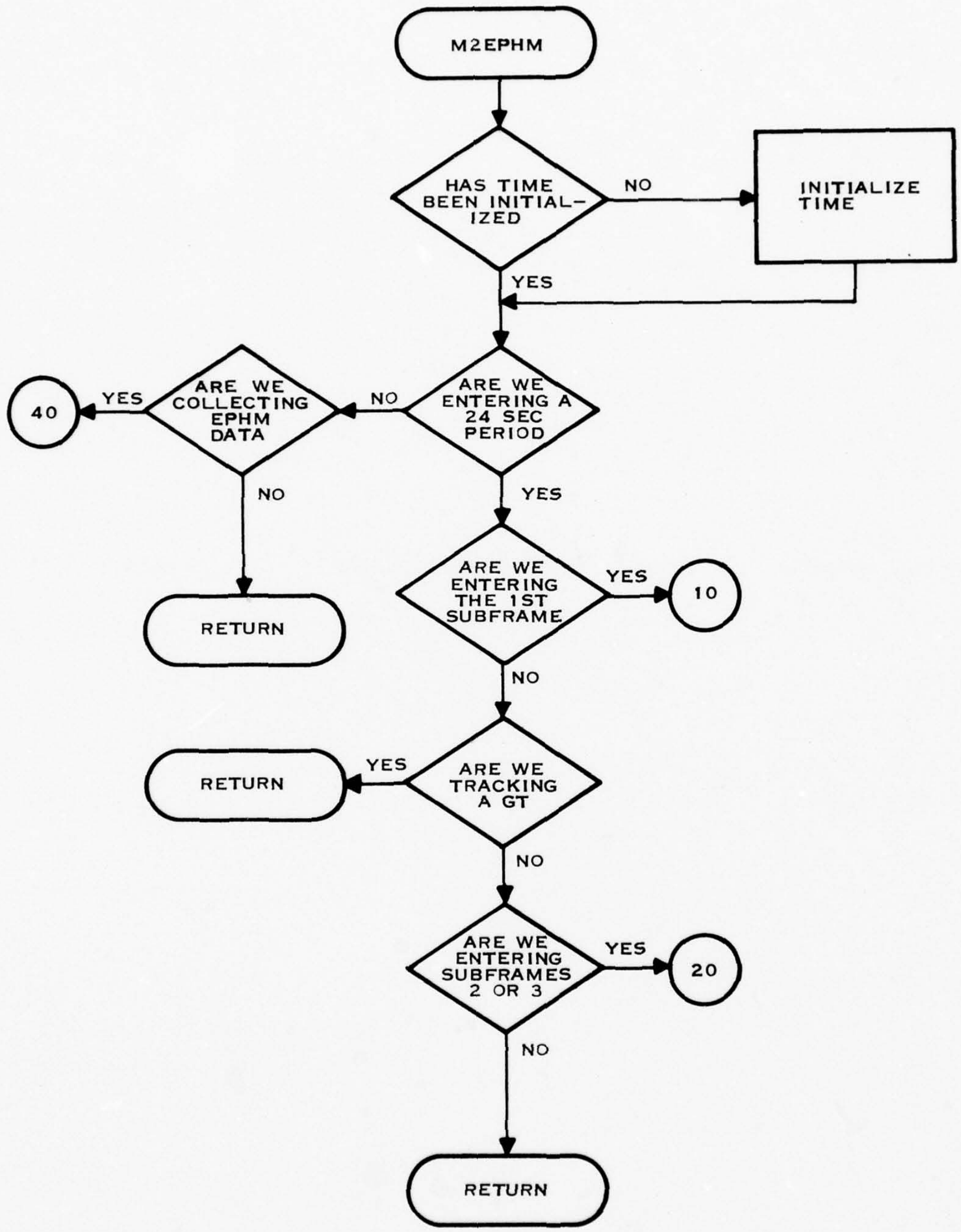
4
SET MOD = 5
5
18
SV AWAITING P REACQ
TIME LIMIT = MQPCFL (P CODE FAIL)
11
SET MOD = 5
IS TIMER < LIMIT
YES
5
NO
ISSUE FLASHING 'T' TO CDU
ARE WE WAITING TO INCREMENT MNPSTK
YES
NO
DECREMENT MNPSTK
IF WE NEED A.H. NOW, SET TO SV THAT JUST TIMED OUT
SET APPROPRIATE THRESHOLD FOR GT AND SV
19

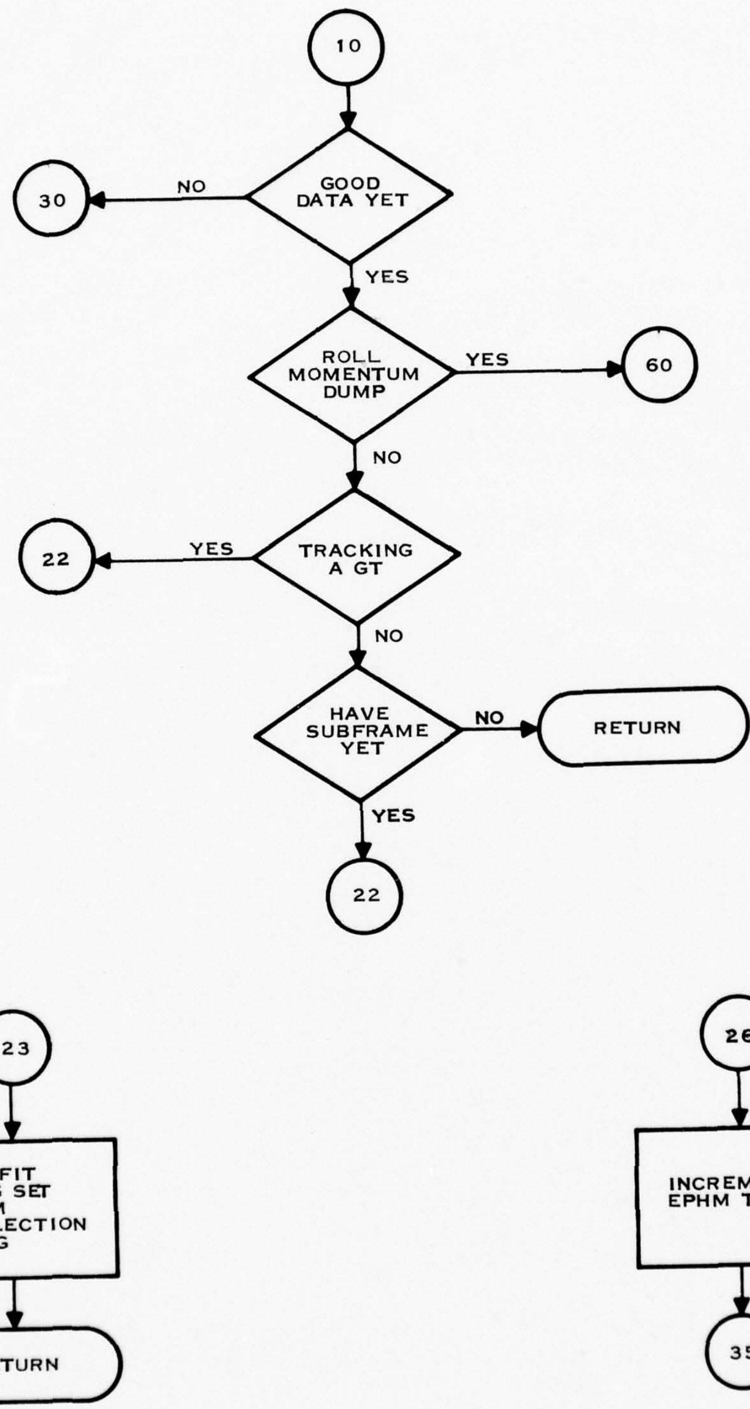

90
ILLEGAL SV STATUS, SEND ERROR TO X3ERR
4
30
TURN ON TIMER MOD = 8 TIME LIMIT = MQNWSV
21
15
TURN ON TIMER
18
40
MOD = 24 TURN TIMER ON, SET TIMER LIMIT TO MQPRFL
21
10
TURN TIMER ON, SET LIMIT TO MQPIFL
11
41
MOD = 5 TURN TIMER ON, SET TIME LIMIT TO MQPRFL
21
45
MOD = 4 TURN TIMER ON, SET TIME LIMIT TO MQCAFL
21
55
MOD = 5
8

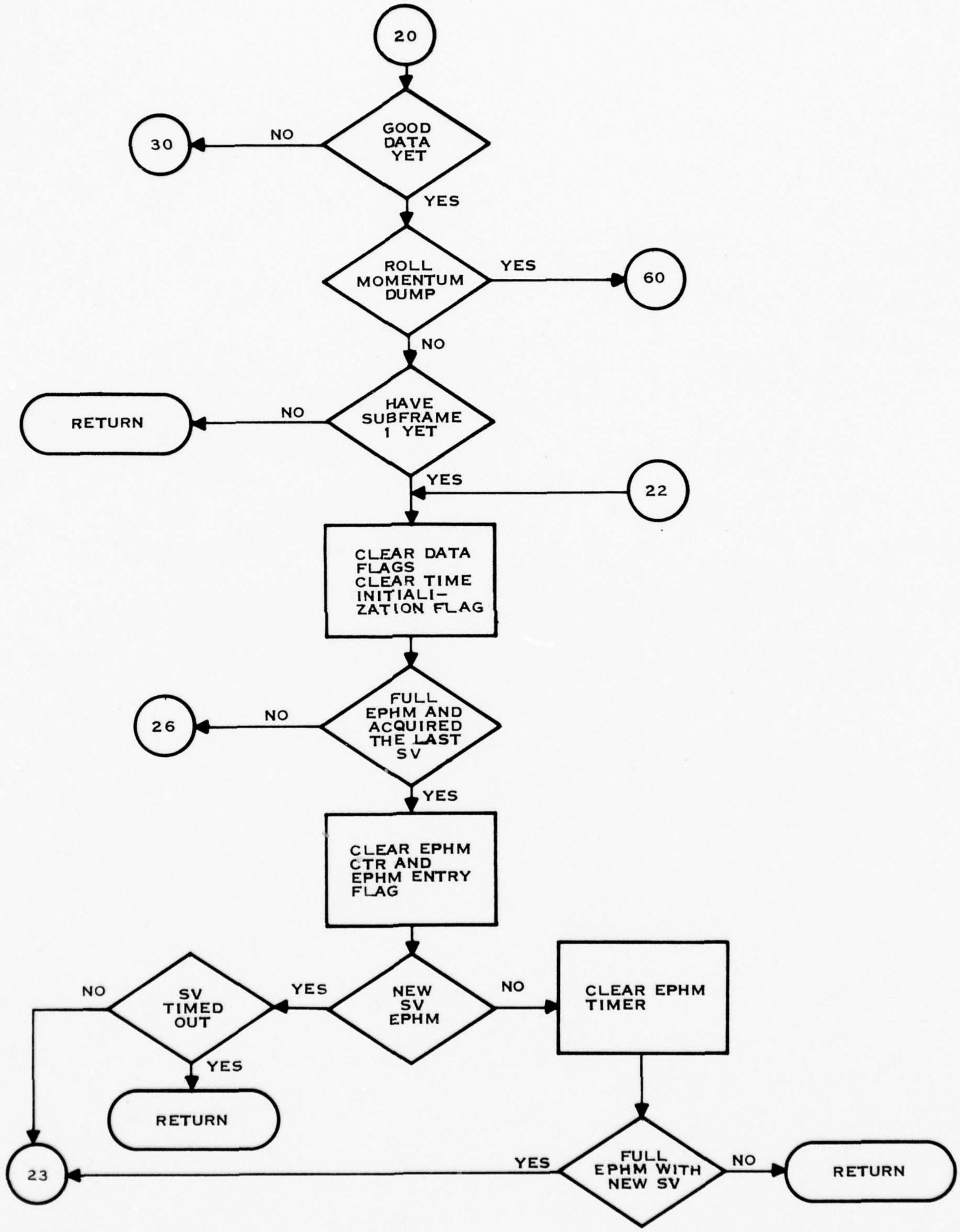

50
SV HAS JUST SET
CHANGE STATUS
OLD NEW
14 → 15
17 → 4
SET MOD = 4 UNLESS MCSTAT = 4, THEN MOD = 8
WAITING TO INCREMENT MNPSTK
YES
NO
INCREMENT MNPSTK
DECREMENT MVSVTR, REARRANGE MVELVT
IF WE NEED A SV FOR A.H. SET EQUAL TO ONE THAT SET
26

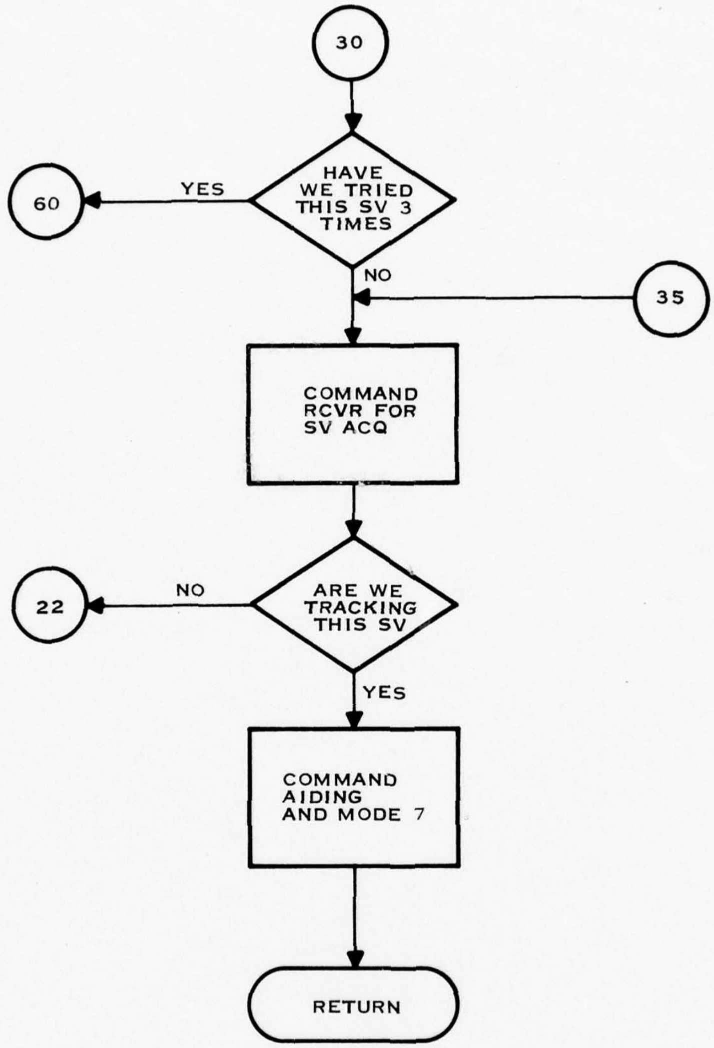

21
TIMER < TIME LIMIT
YES
5
NO
NAV CURRENTLY REPLACING A SV
YES
PUT REQUEST IN WAIT STATE
NO
REQUEST REPLACEMENT FOR FAILED SV
DO WE NEED TO REARRANGE MVELVT
NO
YES
DO WE NEED TO SWITCH A.H.
YES
SET FLAG TO DROP A.H. AND LOOK FOR ANOTHER
NO
REARRANGE MVELVT, SET MOD = 8
26
CLEAR SV TIMERS
8

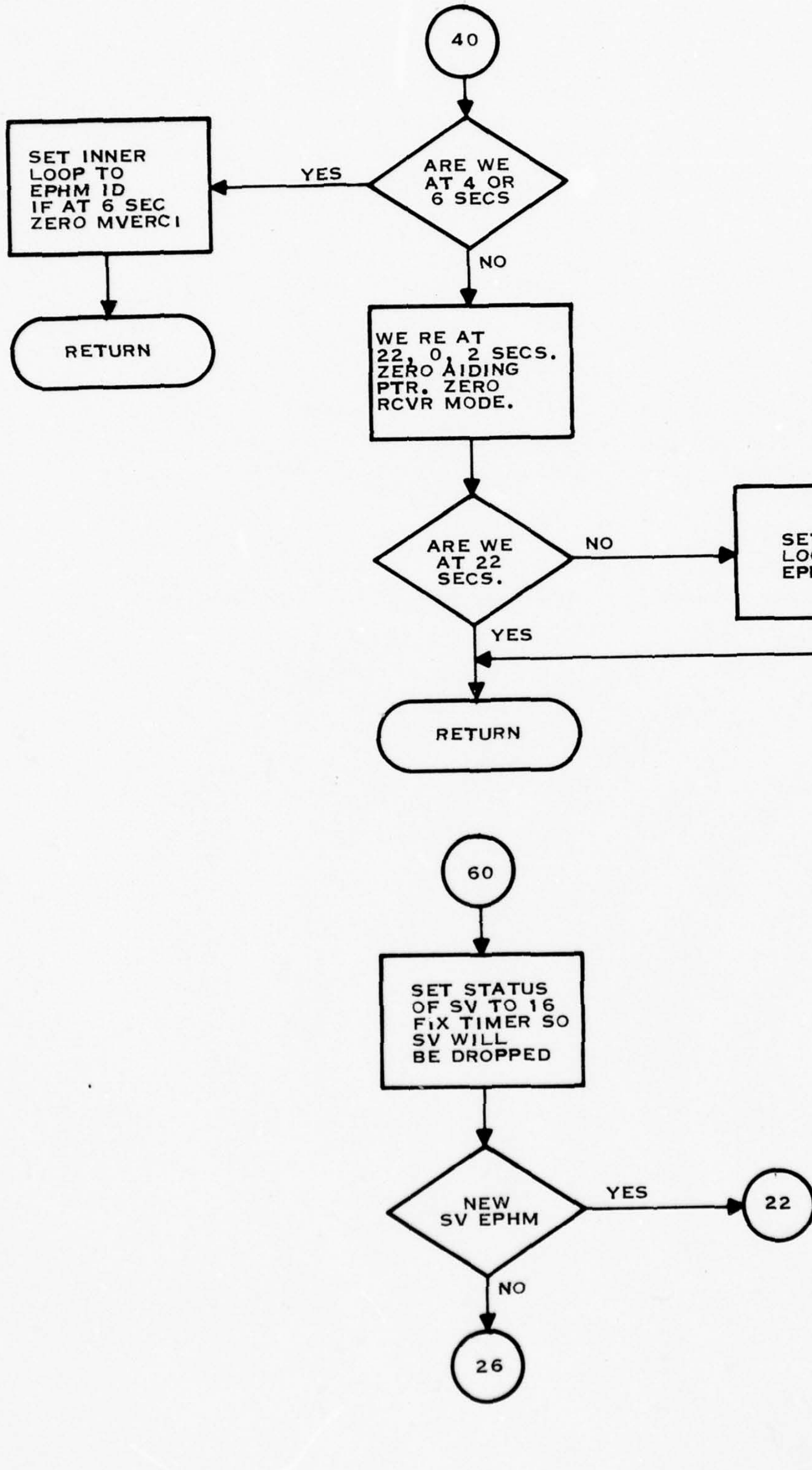

M2EPHM
INITIALIZE
ARE WE ENTERING A SUBFRAME WE NEED
NO
RETURN
YES
COLLECT EPHM DATA
DO WE HAVE ALL SUBFRAMES
NO
RETURN
YES
IS THIS A NEW SV EPHM
YES
TURN OFF EPHM MODULE
RETURN
NO
DO WE HAVE ALL SV'S
YES
TURN OFF EPHM MODULE
RETURN
NO
INCREMENT SV COUNTER
RETURN

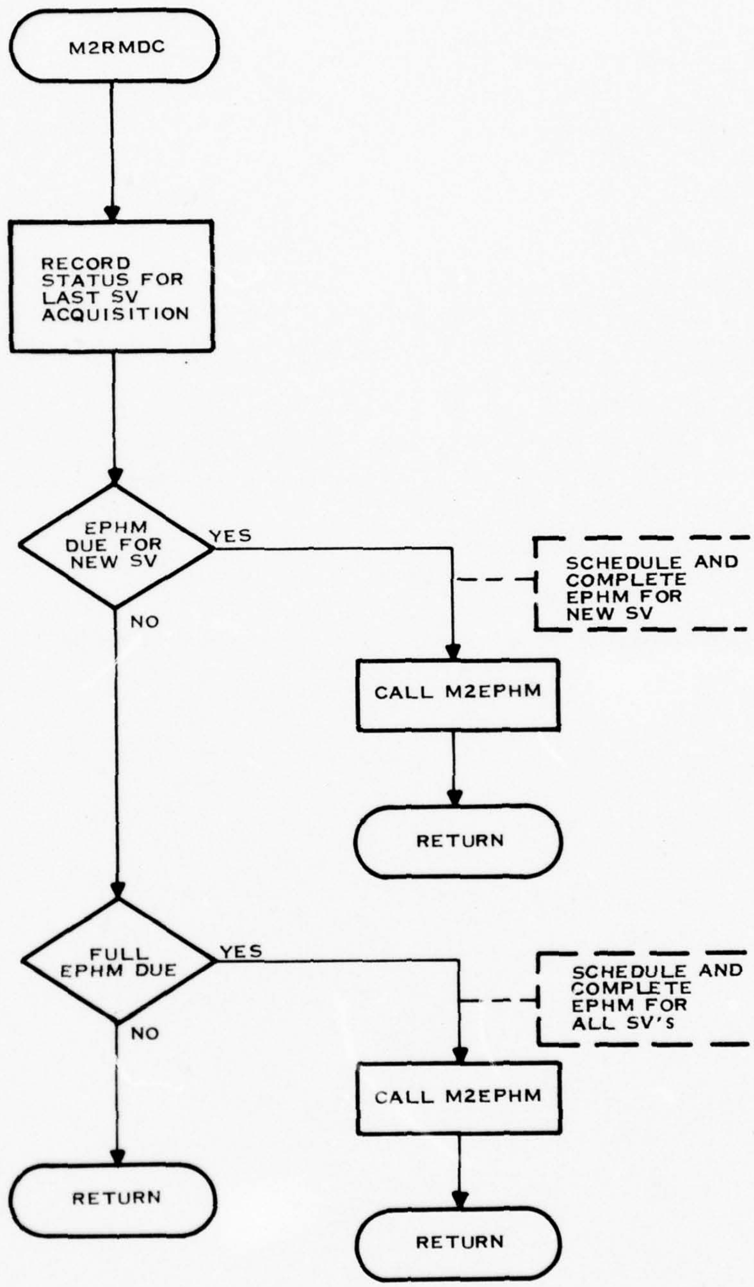

M2EPHM
HAS TIME BEEN INITIAL-IZED
NO
INITIALIZE TIME
YES
ARE WE ENTERING A 24 SEC PERIOD
NO
ARE WE COLLECTING EPHM DATA
YES
40
NO
RETURN
YES
ARE WE ENTERING THE 1ST SUBFRAME
YES
10
NO
ARE WE TRACKING A GT
YES
RETURN
NO
ARE WE ENTERING SUBFRAMES 2 OR 3
YES
20
NO
RETURN

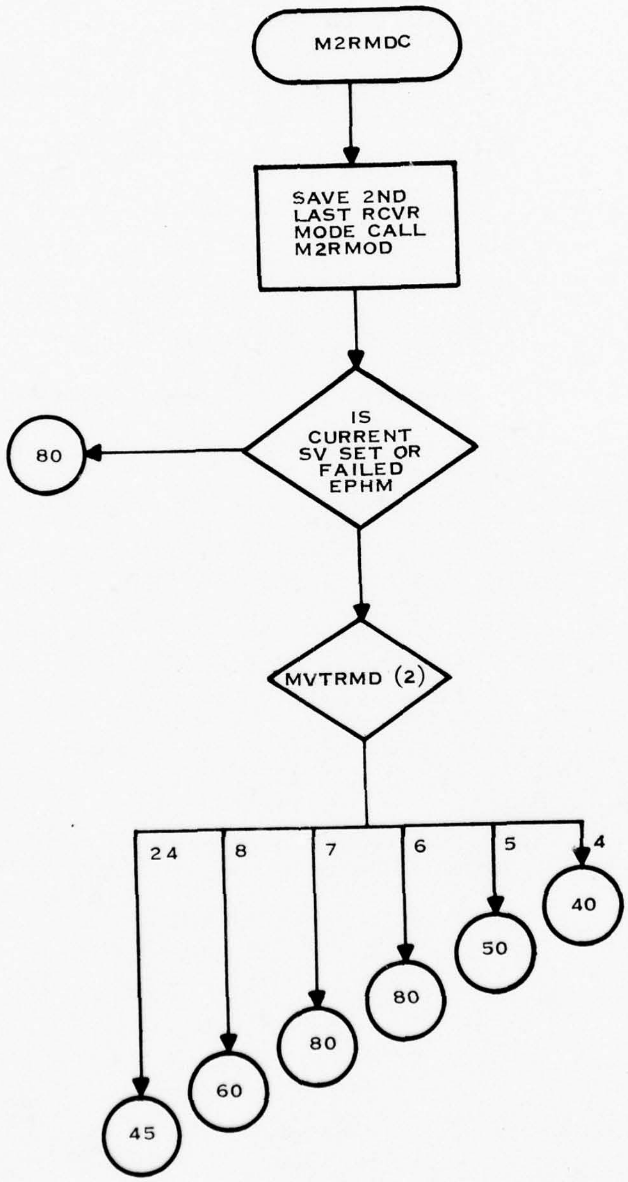

10
GOOD DATA YET
NO
30
YES
ROLL MOMENTUM DUMP
YES
60
NO
TRACKING A GT
YES
22
NO
HAVE SUBFRAME YET
NO
RETURN
YES
22
23
SET FIT FLAG SET EPHM COLLECTION FLAG
RETURN
26
INCREMENT EPHM TIMER
35

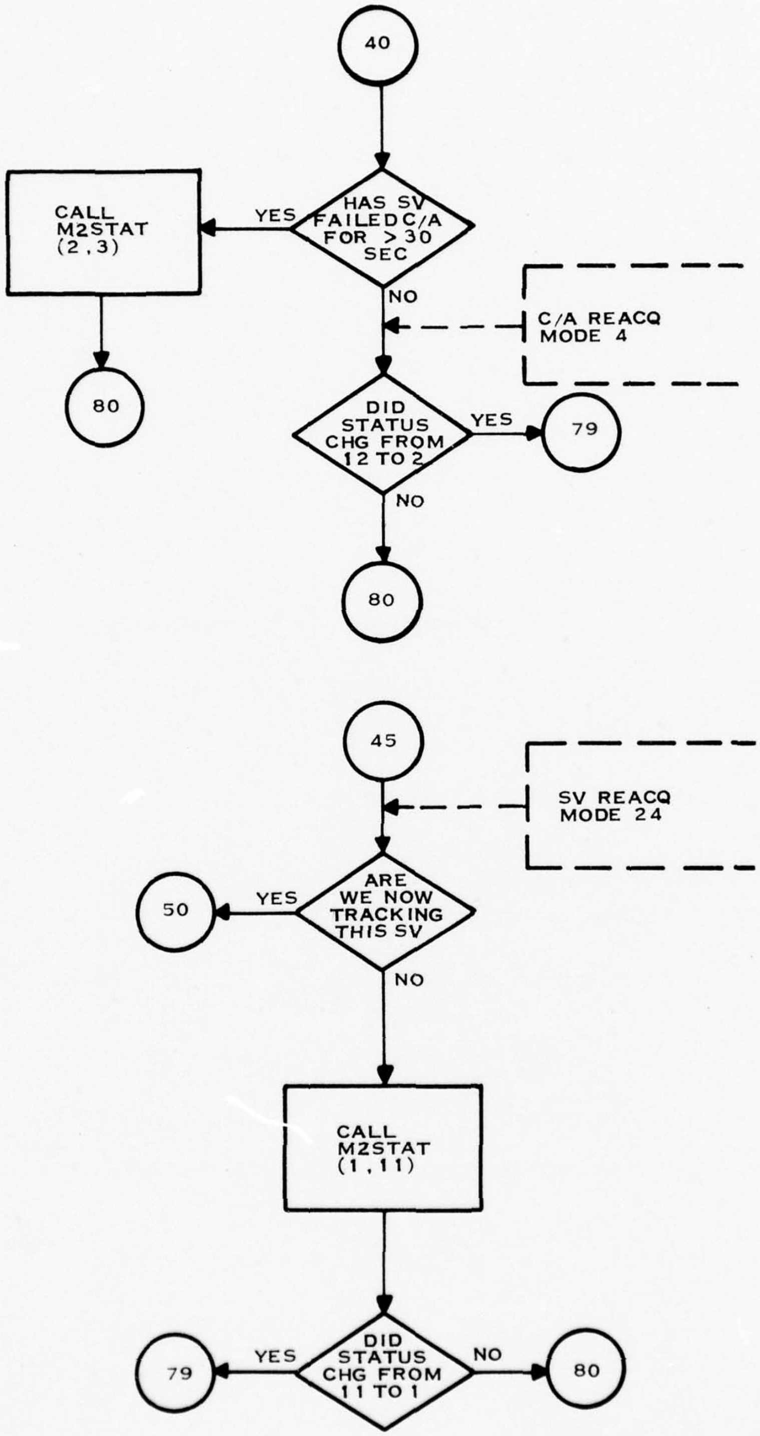

20
GOOD DATA YET
NO
30
YES
ROLL MOMENTUM DUMP
YES
60
NO
HAVE SUBFRAME 1 YET
NO
RETURN
YES
22
CLEAR DATA FLAGS CLEAR TIME INITIALI- ZATION FLAG
FULL EPHM AND ACQUIRED THE LAST SV
NO
26
YES
CLEAR EPHM CTR AND EPHM ENTRY FLAG
NEW SV EPHM
YES
NO
SV TIMED OUT
NO
YES
RETURN
CLEAR EPHM TIMER
FULL EPHM WITH NEW SV
YES
23
NO
RETURN


30
HAVE WE TRIED THIS SV 3 TIMES
YES
60
NO
35
COMMAND RCVR FOR SV ACQ
ARE WE TRACKING THIS SV
NO
22
YES
COMMAND AIDING AND MODE 7
RETURN

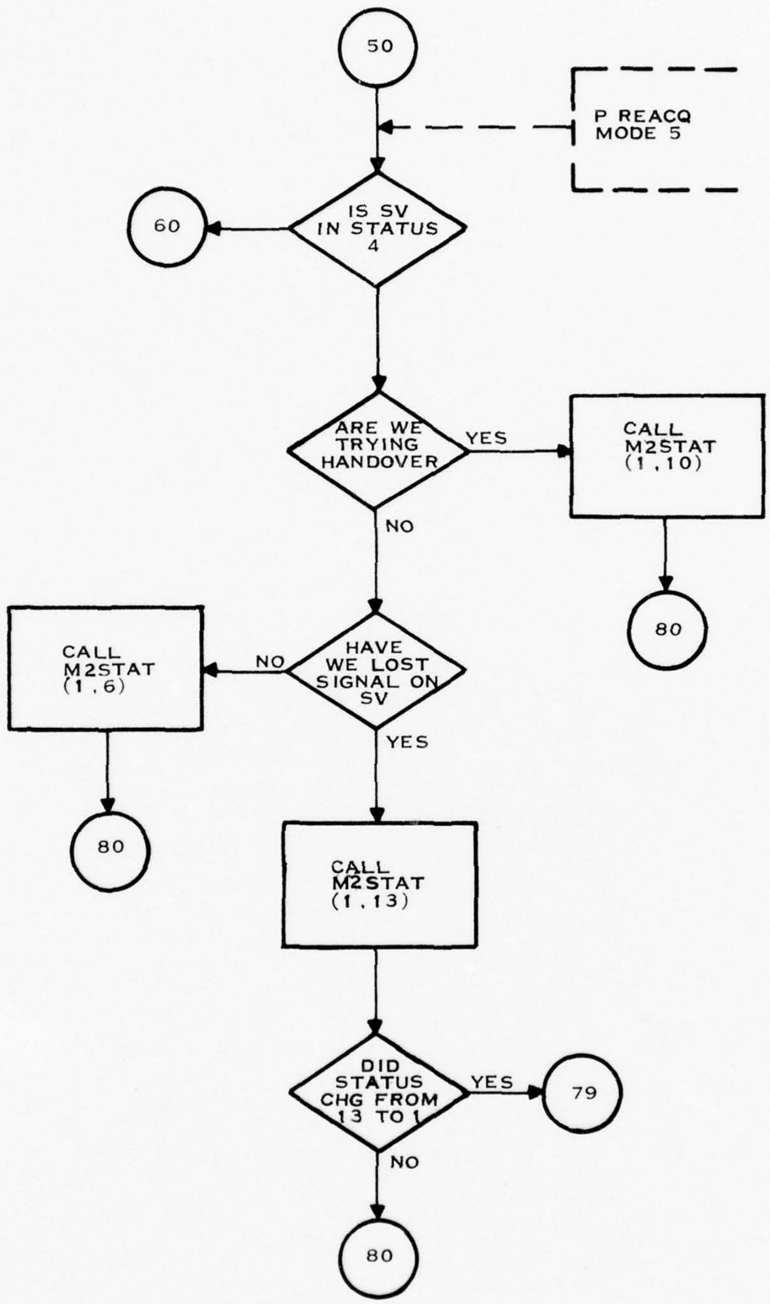

40
ARE WE AT 4 OR 6 SECS
YES
SET INNER LOOP TO EPHM ID IF AT 6 SEC ZERO MVERCI
RETURN
NO
WE RE AT 22, 0, 2 SECS. ZERO AIDING PTR. ZERO RCVR MODE.
ARE WE AT 22 SECS.
NO
SET INNER LOOP TO EPHM ID
YES
RETURN
60
SET STATUS OF SV TO 16 FIX TIMER SO SV WILL BE DROPPED
NEW SV EPHM
YES
22
NO
26

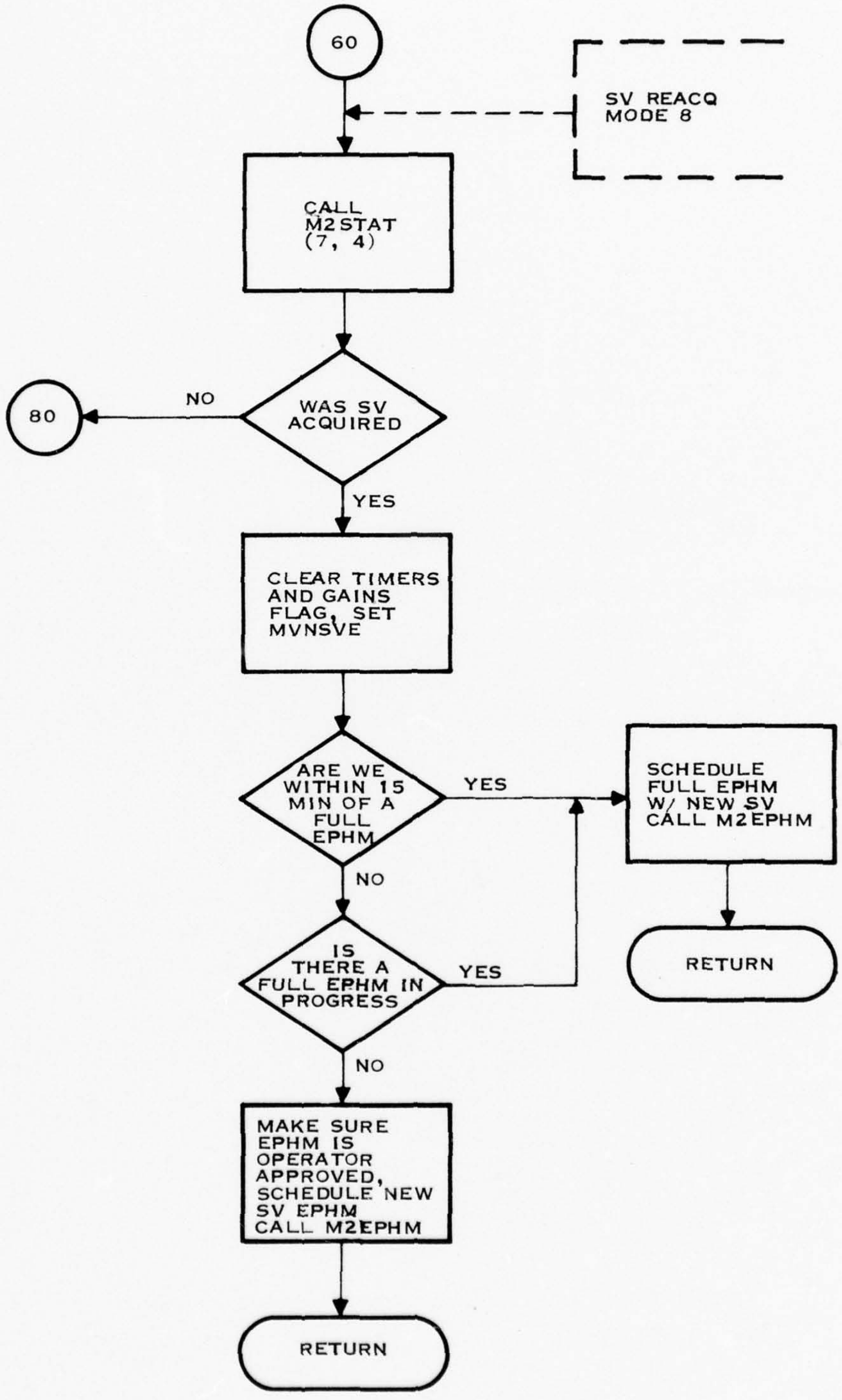

M2RMDC
RECORD STATUS FOR LAST SV ACQUISITION
EPHM DUE FOR NEW SV
YES
NO
SCHEDULE AND COMPLETE EPHM FOR NEW SV
CALL M2EPHM
RETURN
FULL EPHM DUE
YES
NO
SCHEDULE AND COMPLETE EPHM FOR ALL SV'S
CALL M2EPHM
RETURN
RETURN

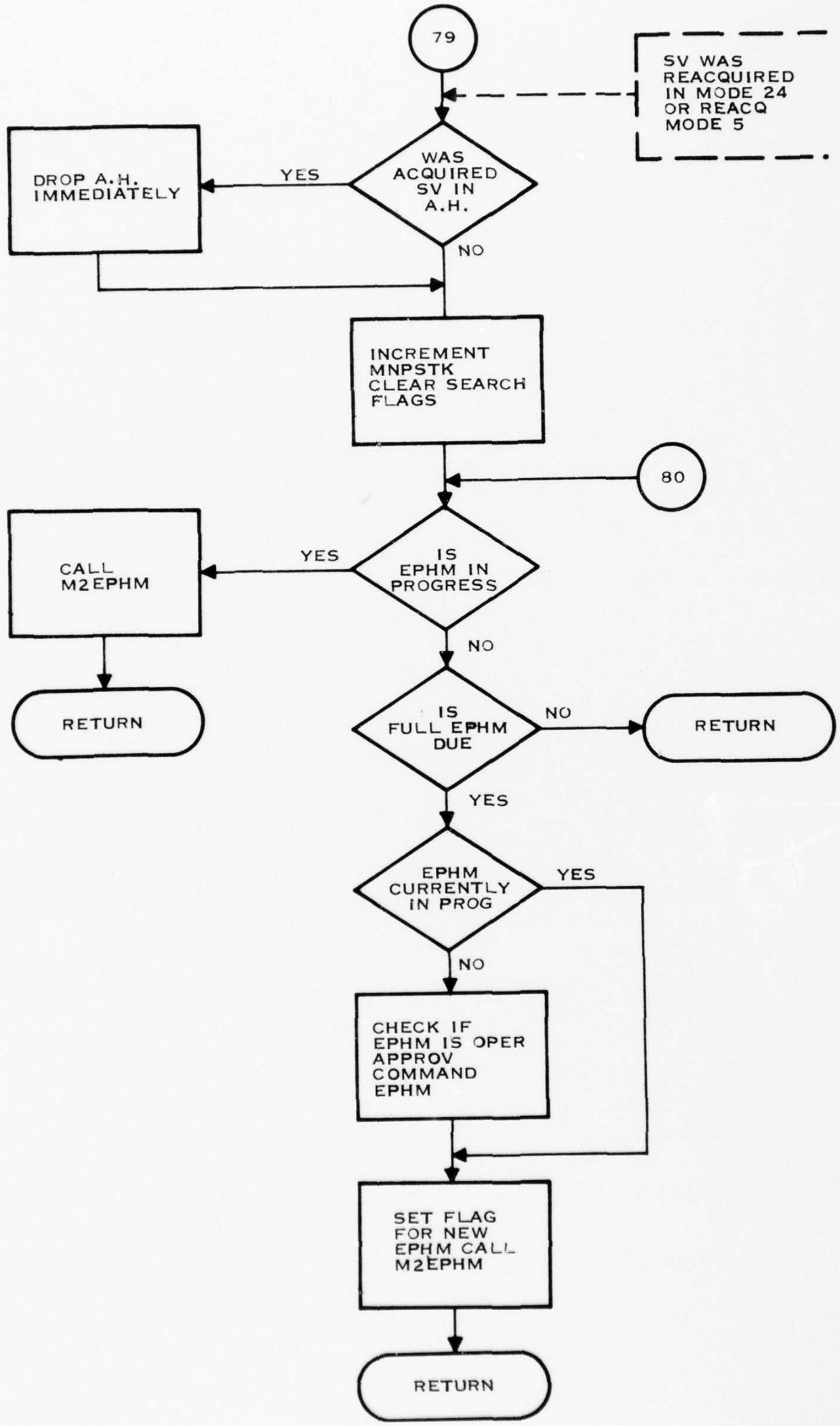

M2RMDC
SAVE 2ND LAST RCVR MODE CALL M2RMOD
IS CURRENT SV SET OR FAILED EPHM
80
MVTRMD (2)
24
8
7
6
5
4
45
60
80
80
50
40



40
HAS SV FAILED C/A FOR >30 SEC
YES
CALL M2STAT (2,3)
80
NO
C/A REACQ MODE 4
DID STATUS CHG FROM 12 TO 2
YES
79
NO
80
45
SV REACQ MODE 24
ARE WE NOW TRACKING THIS SV
YES
50
NO
CALL M2STAT (1,11)
DID STATUS CHG FROM 11 TO 1
YES
79
NO
80


50
P REACQ MODE 5
IS SV IN STATUS 4
60
ARE WE TRYING HANDOVER
YES
CALL M2STAT (1,10)
80
NO
HAVE WE LOST SIGNAL ON SV
NO
CALL M2STAT (1,6)
80
YES
CALL M2STAT (1,13)
DID STATUS CHG FROM 13 TO 1
YES
79
NO
80


60
SV REACQ MODE 8
CALL M2STAT (7, 4)
WAS SV ACQUIRED
NO
80
YES
CLEAR TIMERS AND GAINS FLAG, SET MVNSVE
ARE WE WITHIN 15 MIN OF A FULL EPHM
YES
SCHEDULE FULL EPHM W/ NEW SV CALL M2EPHM
RETURN
NO
IS THERE A FULL EPHM IN PROGRESS
YES
NO
MAKE SURE EPHM IS OPERATOR APPROVED, SCHEDULE NEW SV EPHM CALL M2EPHM
RETURN


79
SV WAS REACQUIRED IN MODE 24 OR REACQ MODE 5
WAS ACQUIRED SV IN A.H.
YES
DROP A.H. IMMEDIATELY
NO
INCREMENT MNPSTK CLEAR SEARCH FLAGS
80
IS EPHM IN PROGRESS
YES
CALL M2EPHM
RETURN
NO
IS FULL EPHM DUE
NO
RETURN
YES
EPHM CURRENTLY IN PROG
YES
NO
CHECK IF EPHM IS OPER APPROV COMMAND EPHM
SET FLAG FOR NEW EPHM CALL M2EPHM
RETURN

APPENDIX D

RECEIVER SEQUENCE CONTROL TASK SYSTEM DESCRIPTIONS

APPENDIX D

RECEIVER SEQUENCE CONTROL

TASK SYSTEM DESCRIPTIONS

This appendix includes the task system descriptions which control the operation of the Receiver Sequence Controller. They are titled as follows:

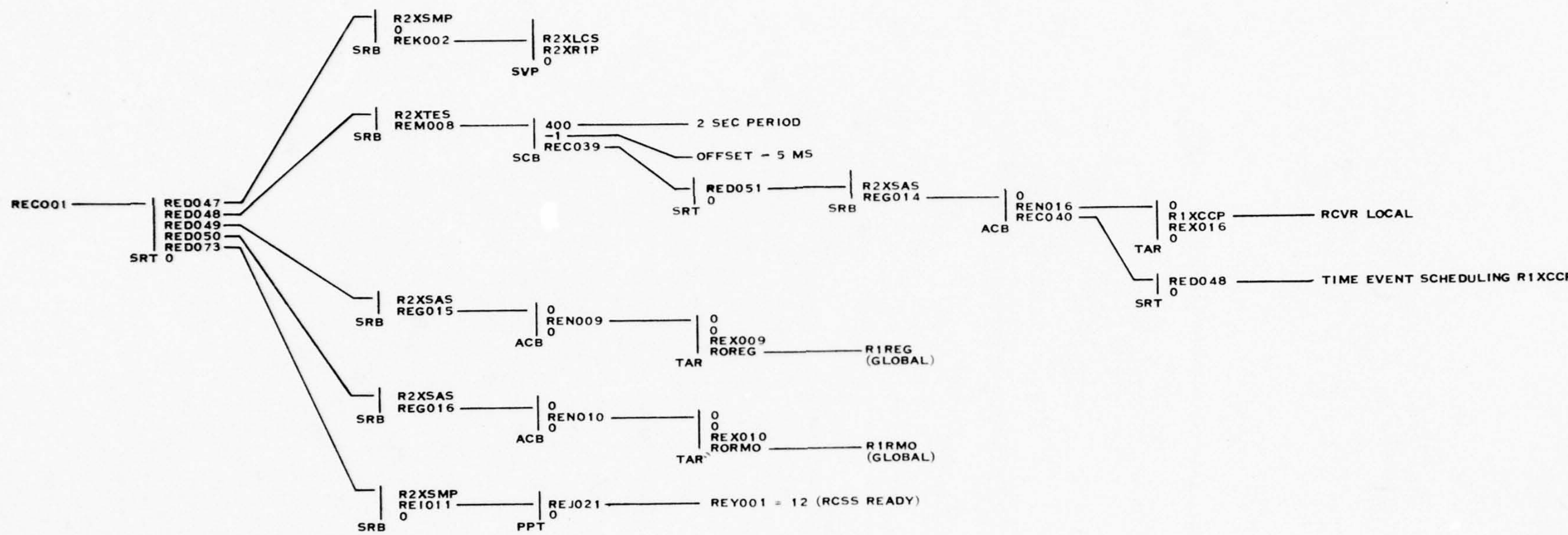


Figure 1. System Initiation Sequence

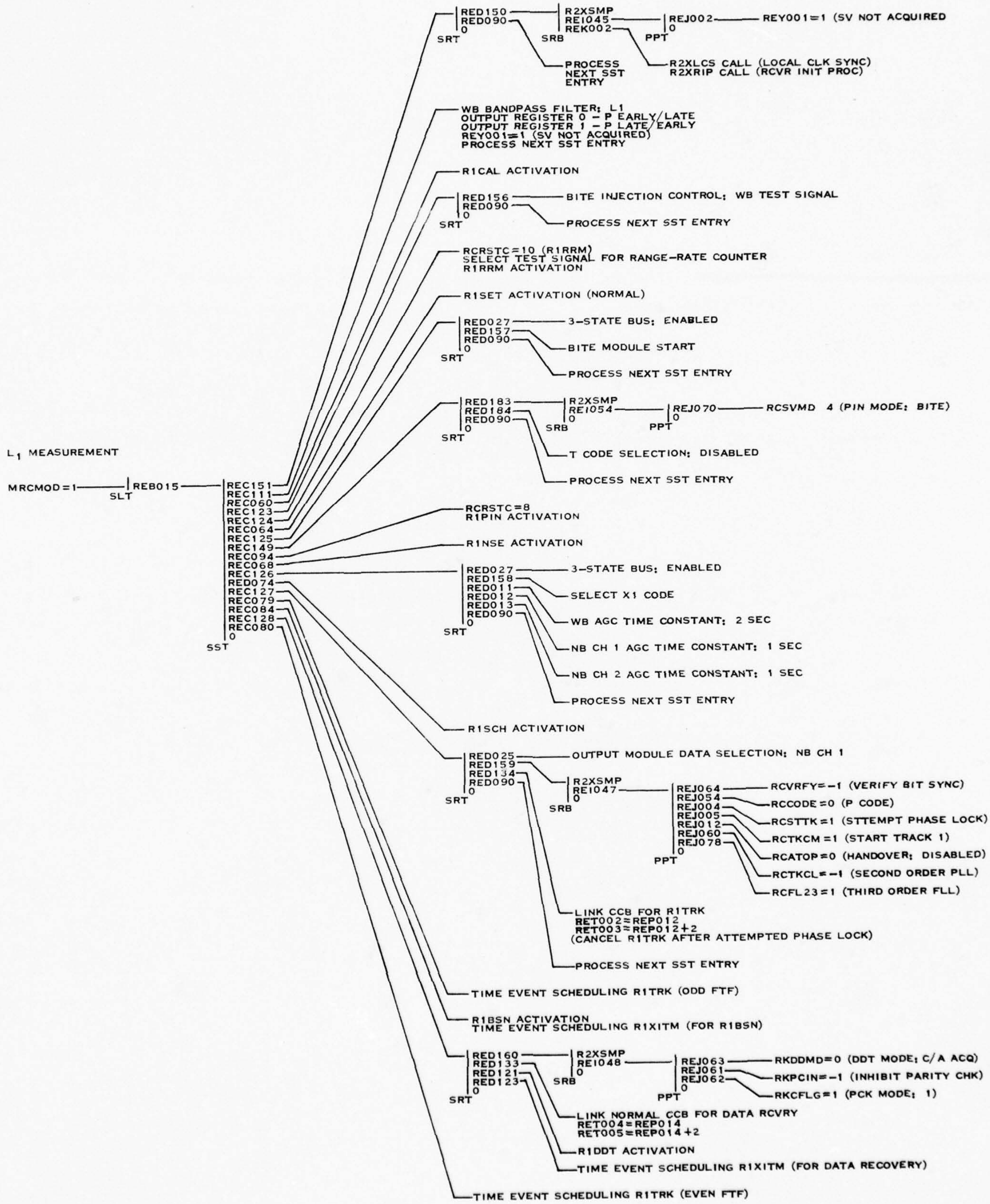


Figure 2. Built-In Test Sequence

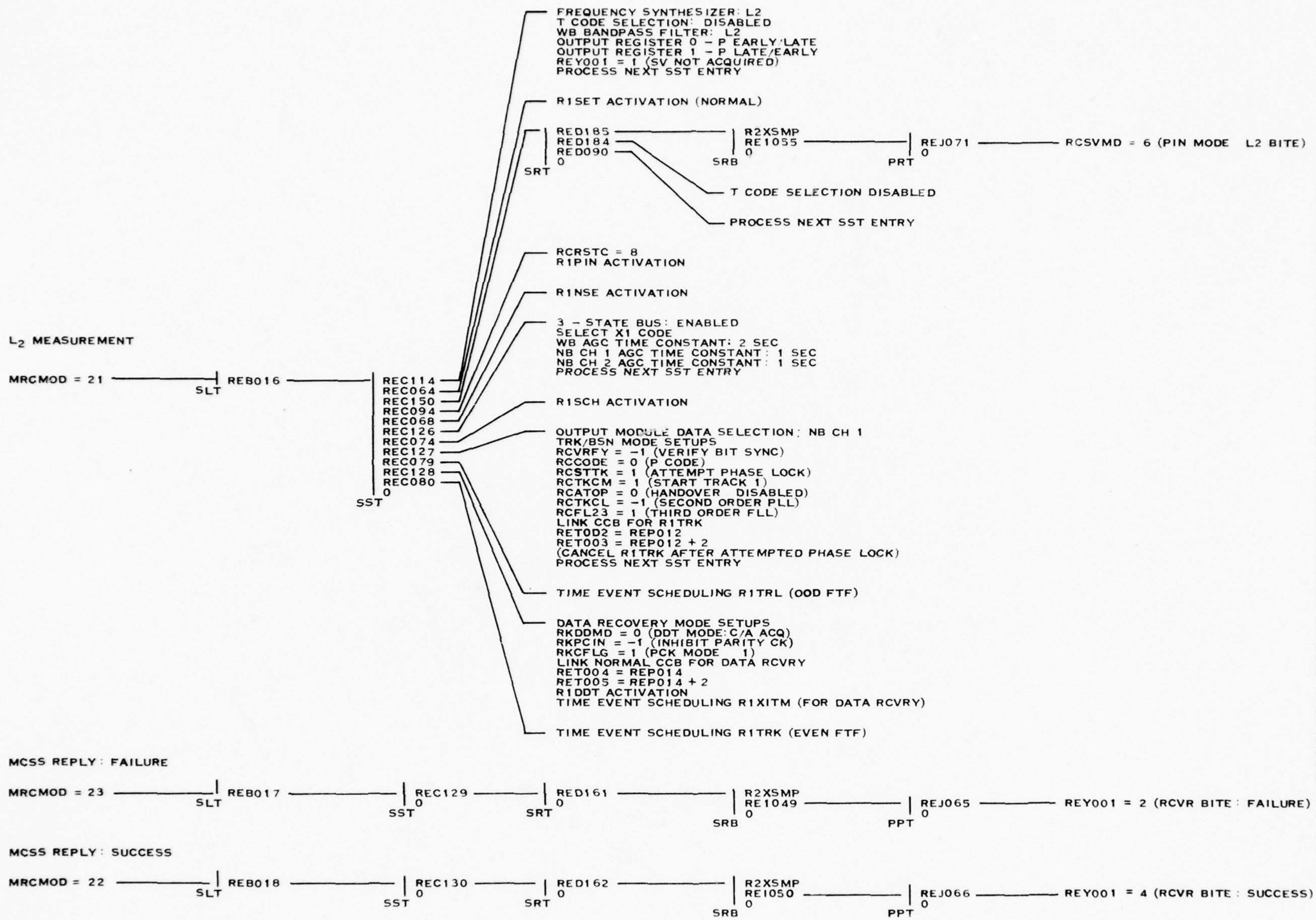


Figure 2. Built-In Test Sequence (Continued)

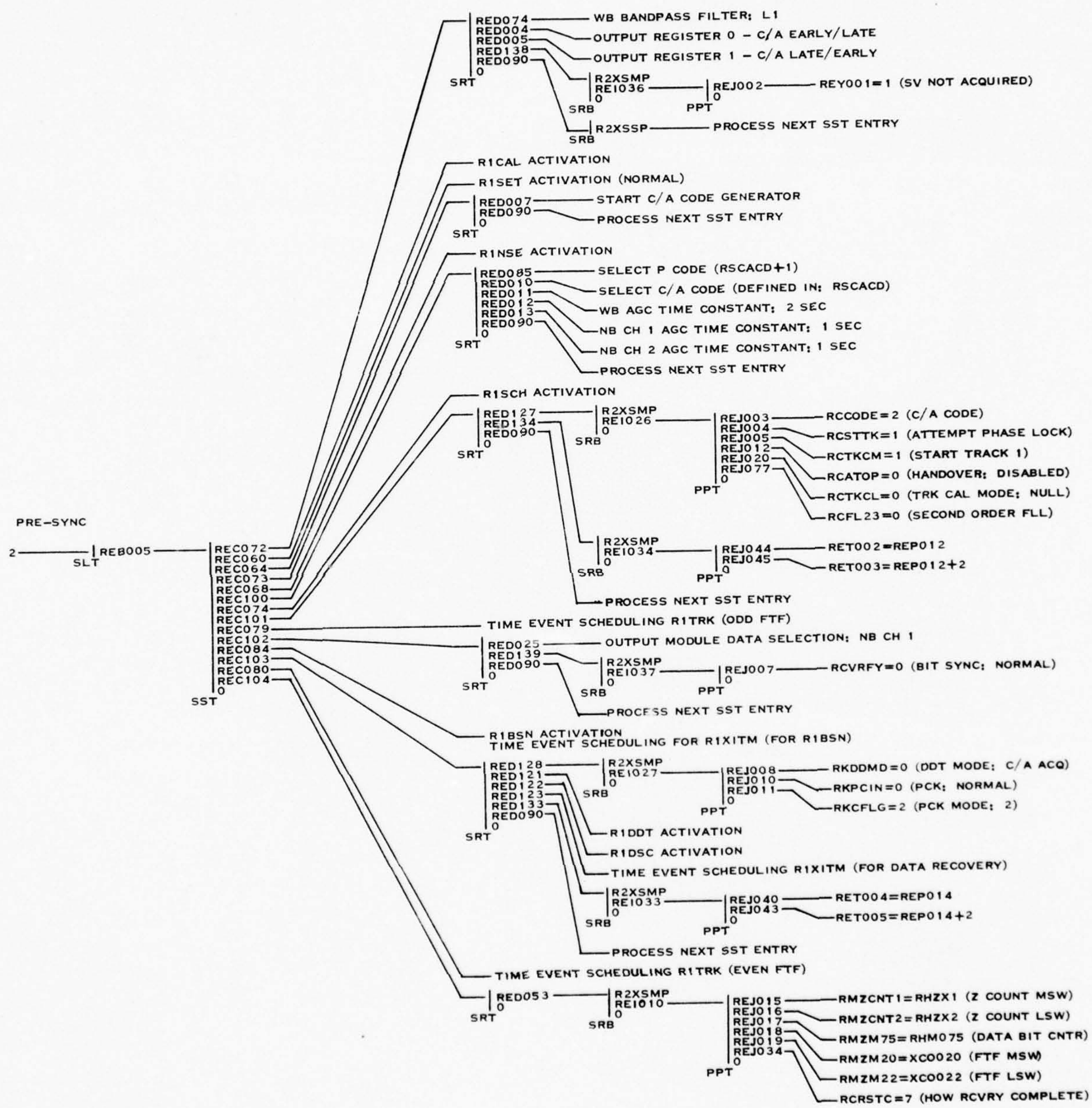


Figure 3. First SV Acquisition Sequence

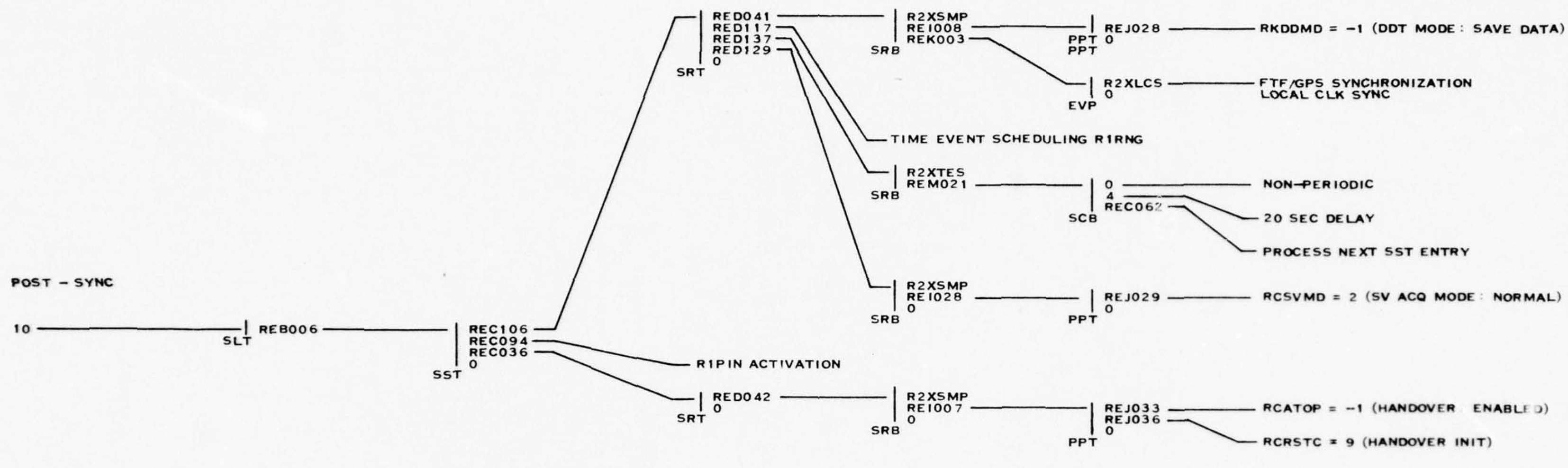


Figure 3. First SV Acquisition Sequence (Continued)

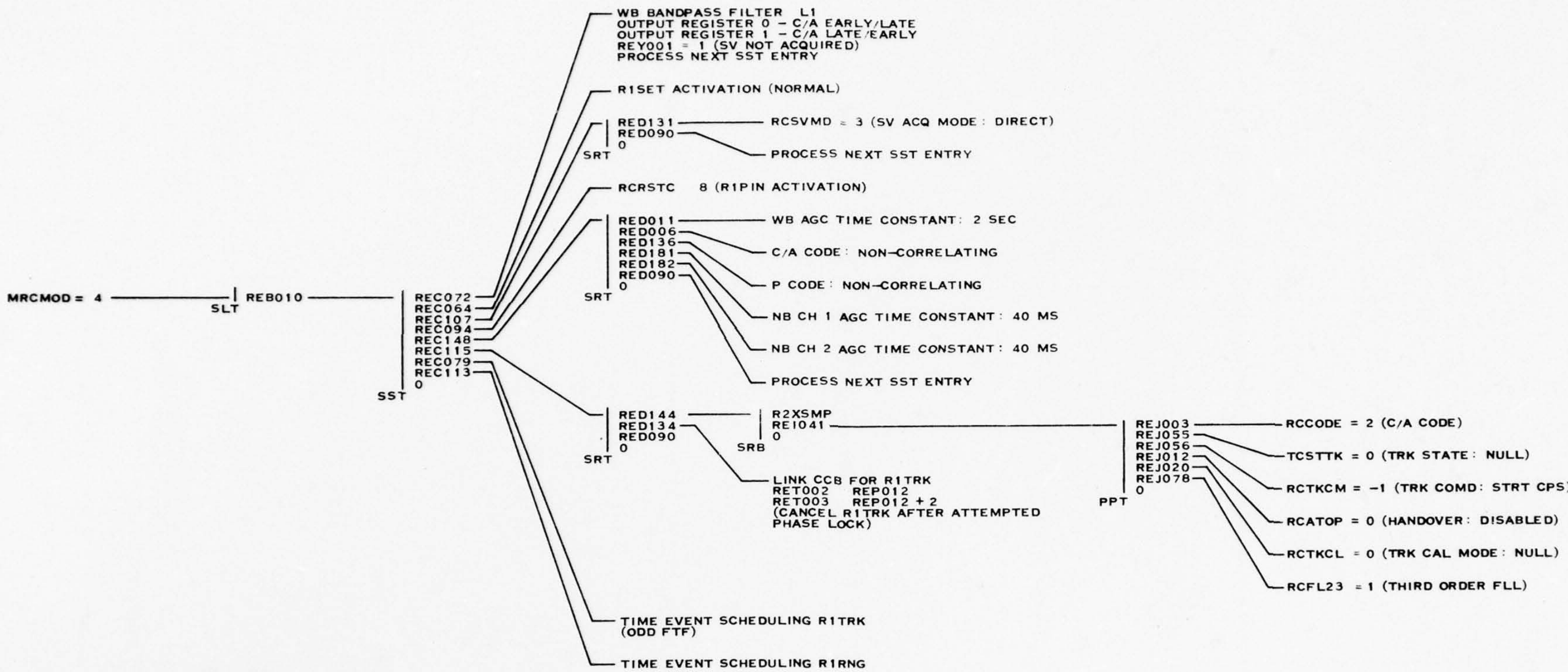


Figure 4. C/A Reacquisition Sequence

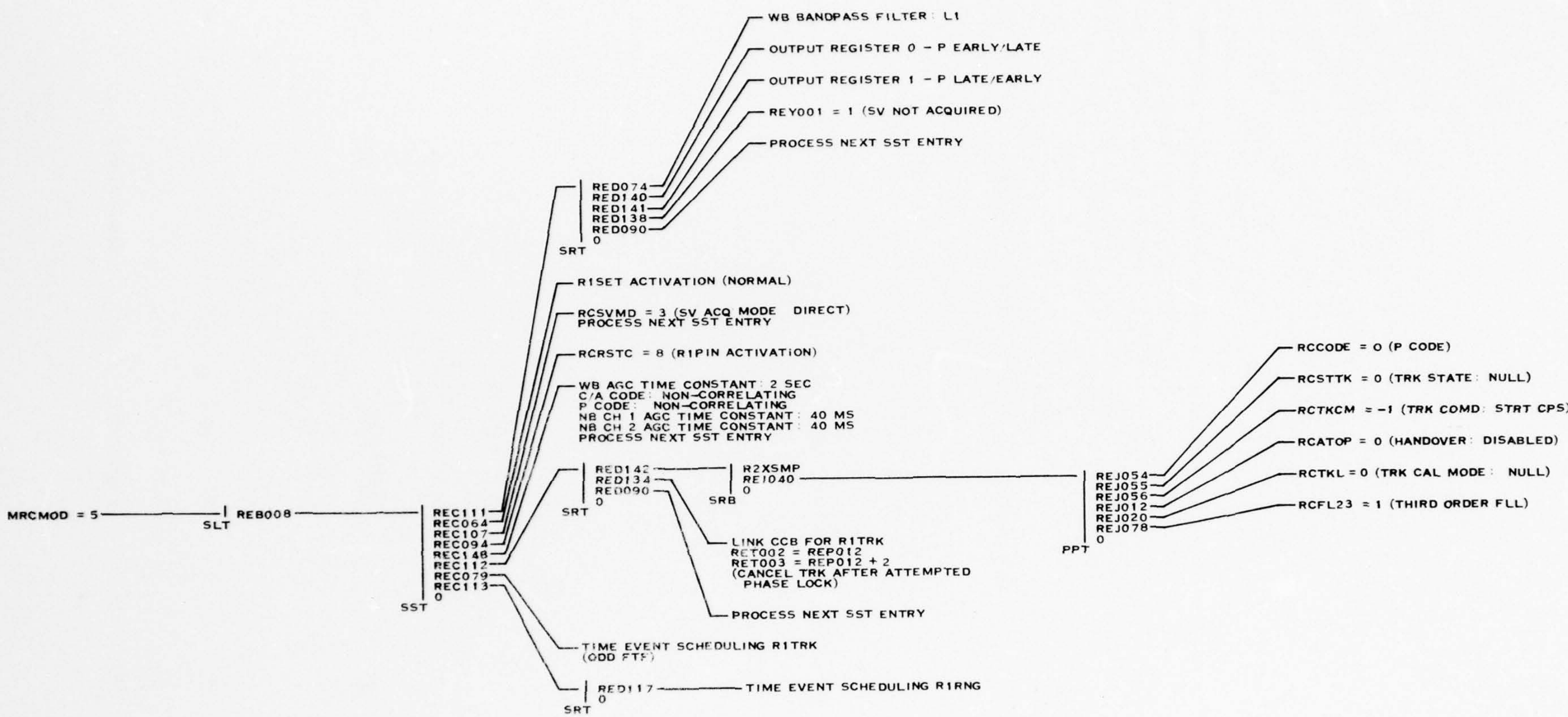


Figure 5. P Reacquisition Sequence (L1)

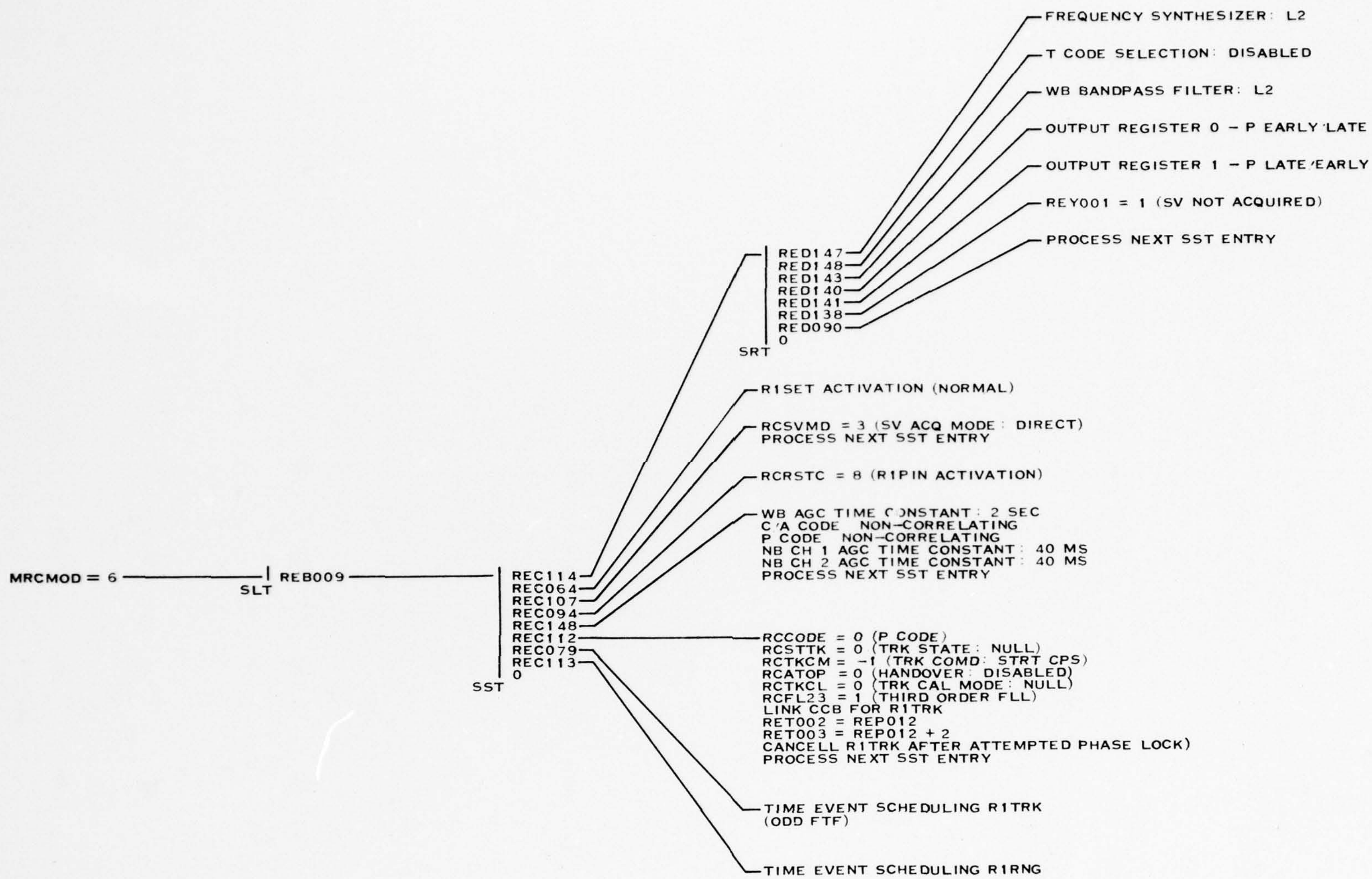


Figure 6. P Reacquisition Sequence (L2)

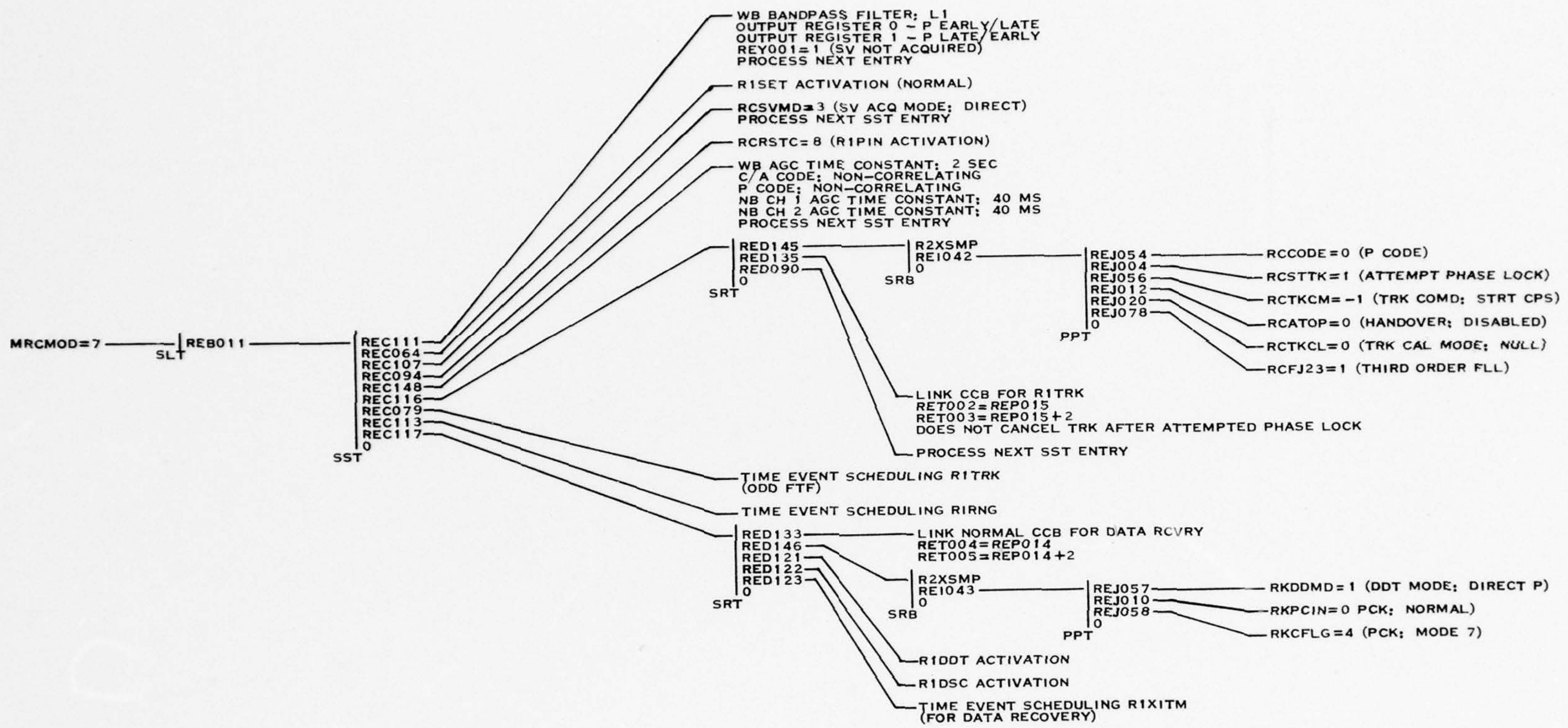


Figure 7. Ephemeris Update Sequence

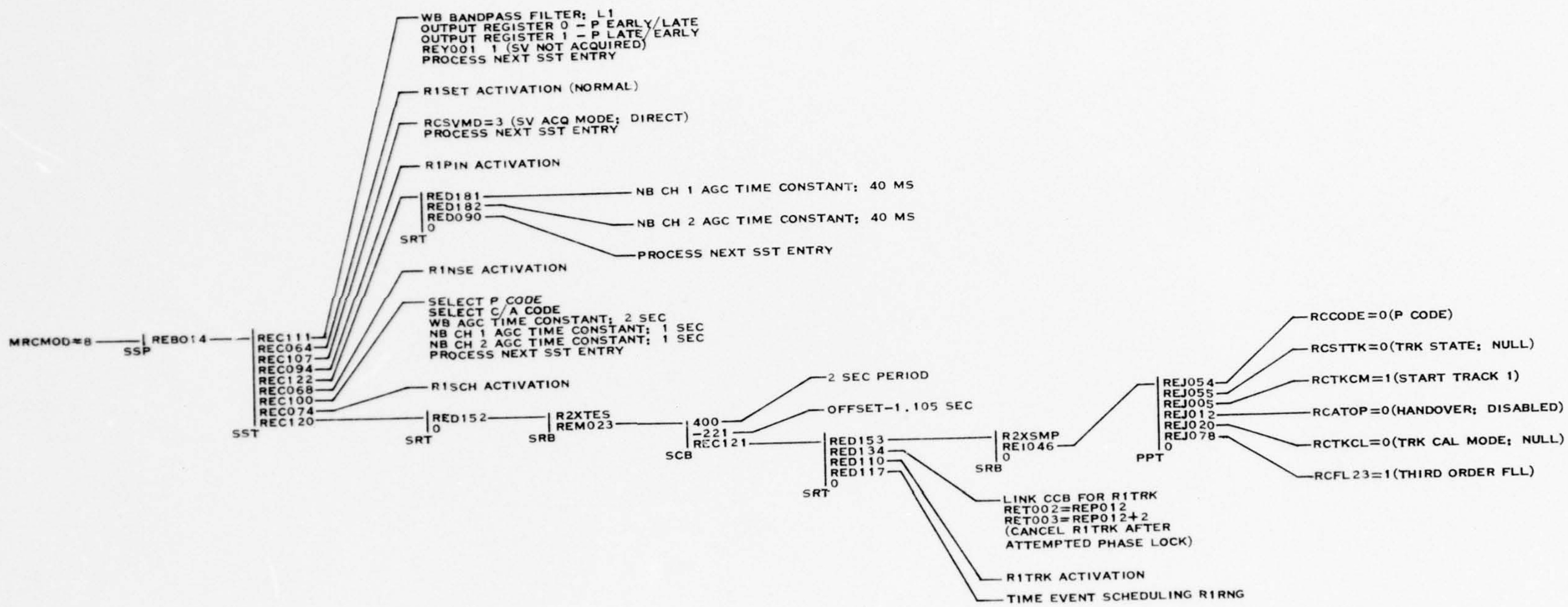


Figure 8. New SV Acquisition Sequence

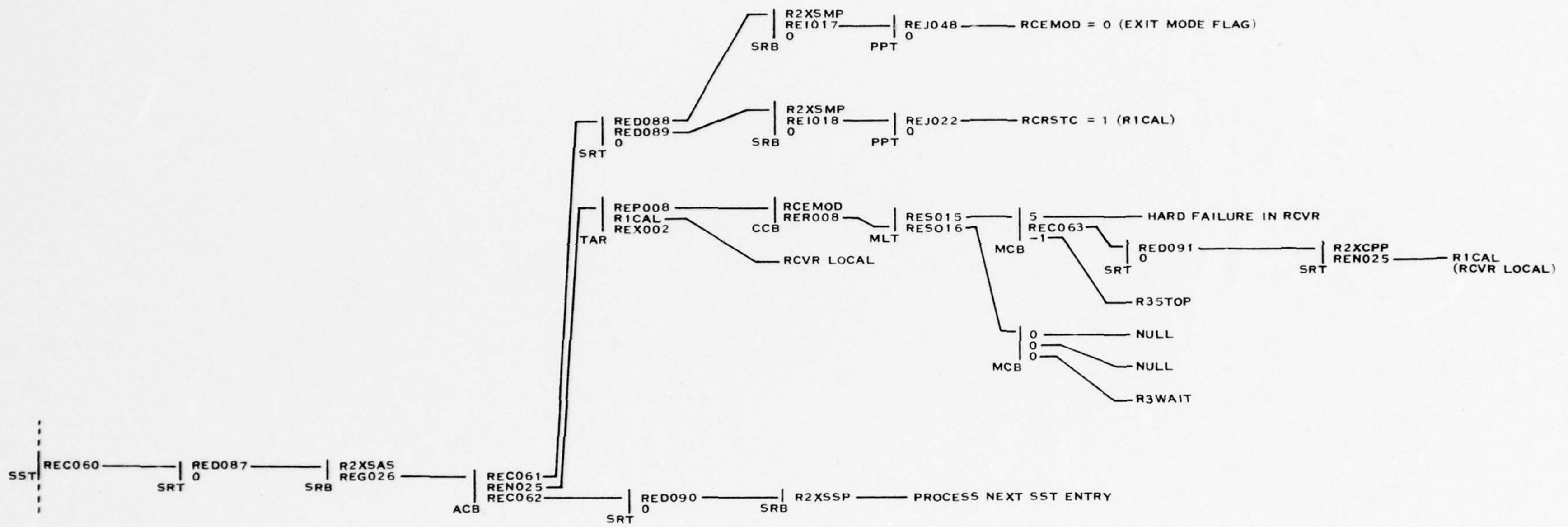


Figure 9. R1CAL Primitive Sequence

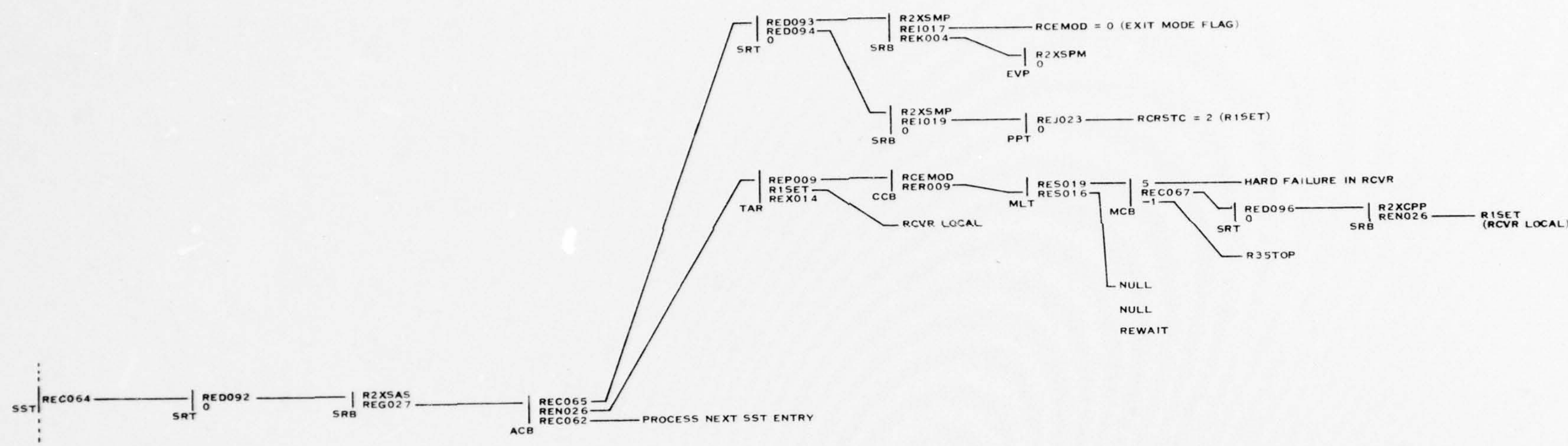


Figure 10. R1SET Primitive Sequence

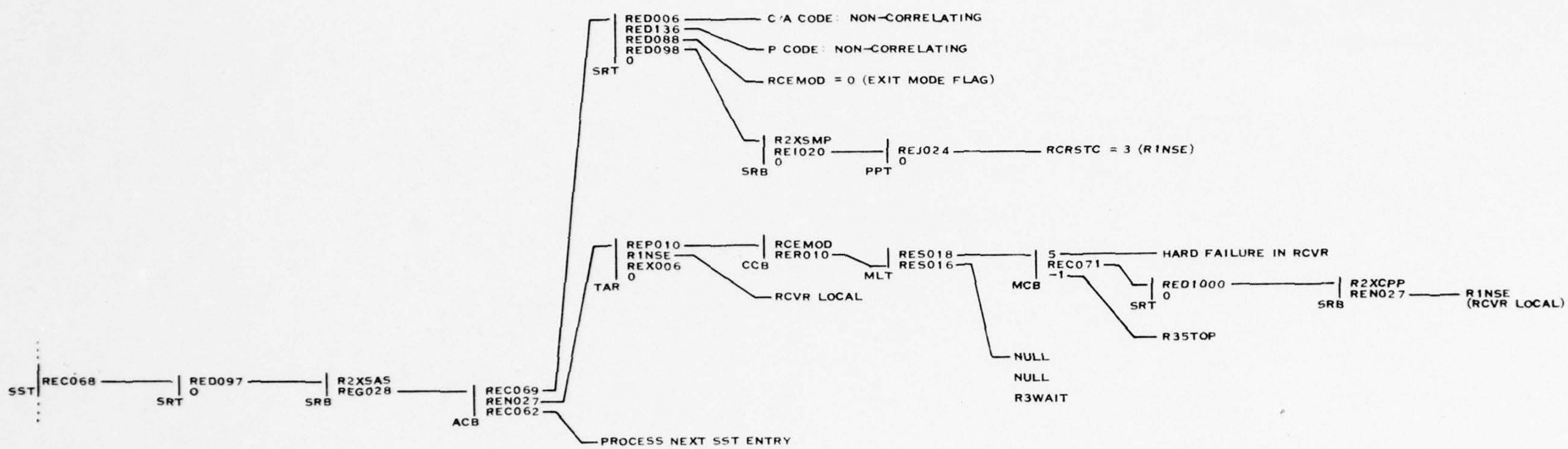


Figure 11. R1NSE Primitive Sequence

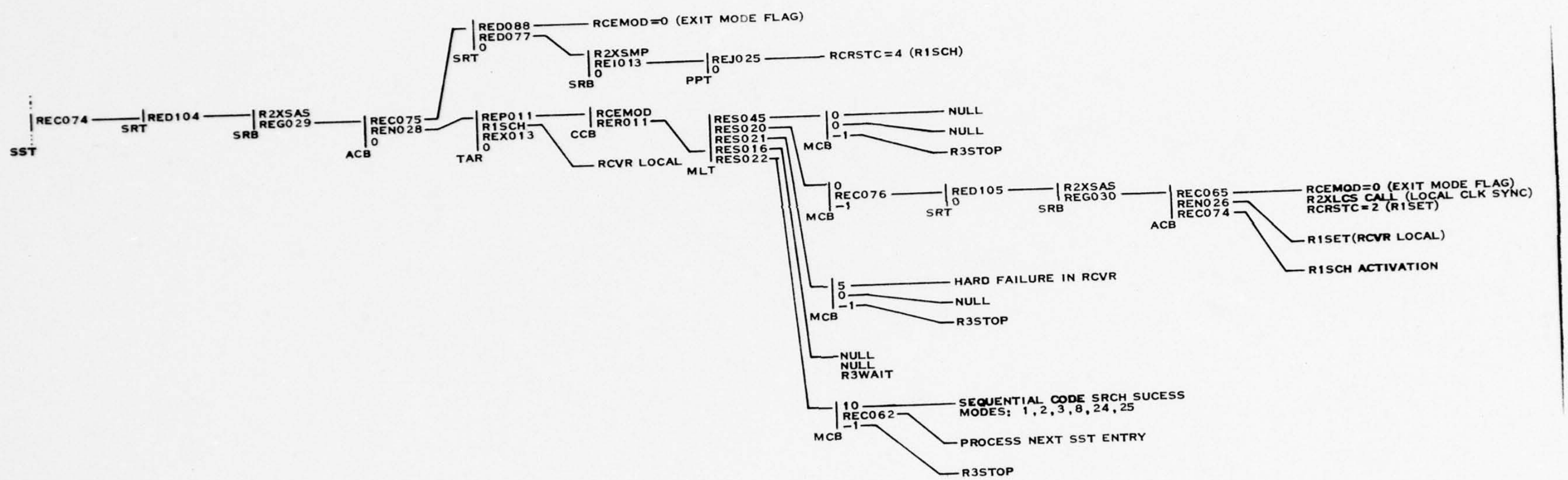


Figure 12. R1SCH Primitive Sequence

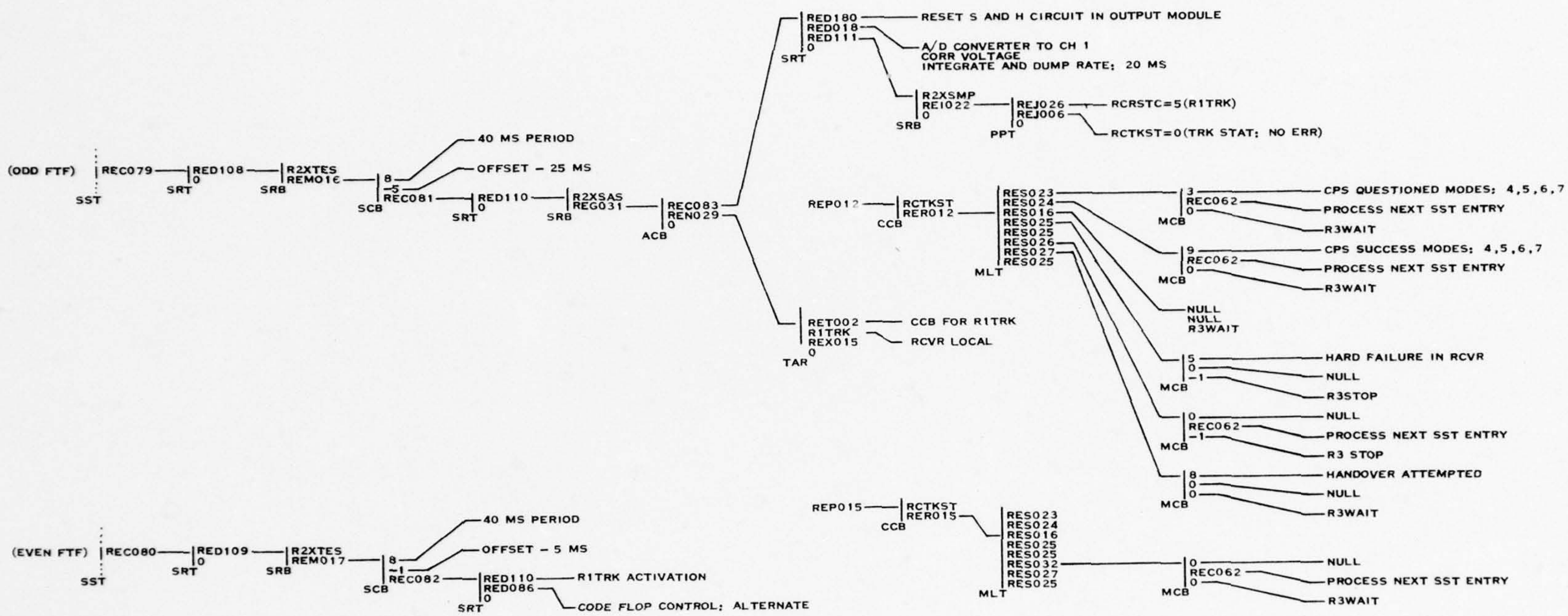


Figure 13. R1TRK Primitive Sequence

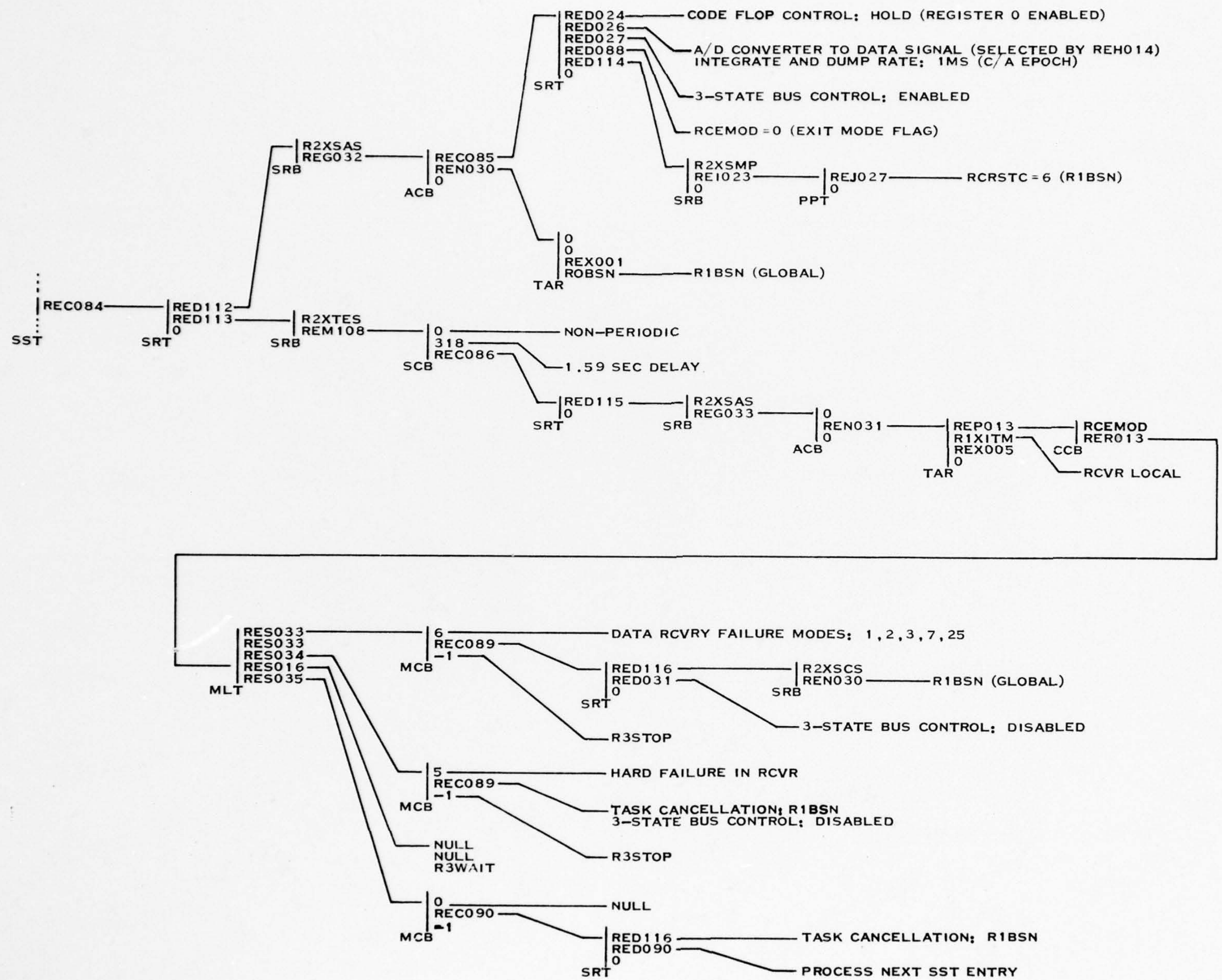


Figure 14. R1BSN Primitive Sequence

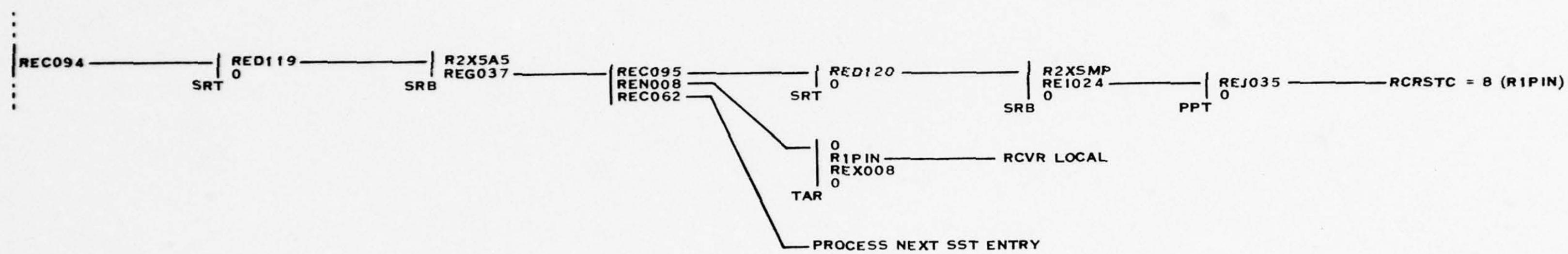


Figure 15. R1PIN Primitive Sequence

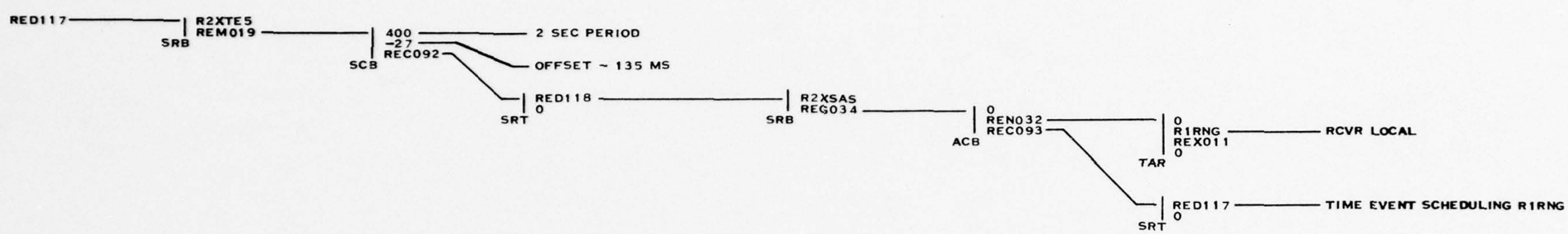


Figure 16. R1RGN Primitive Sequence

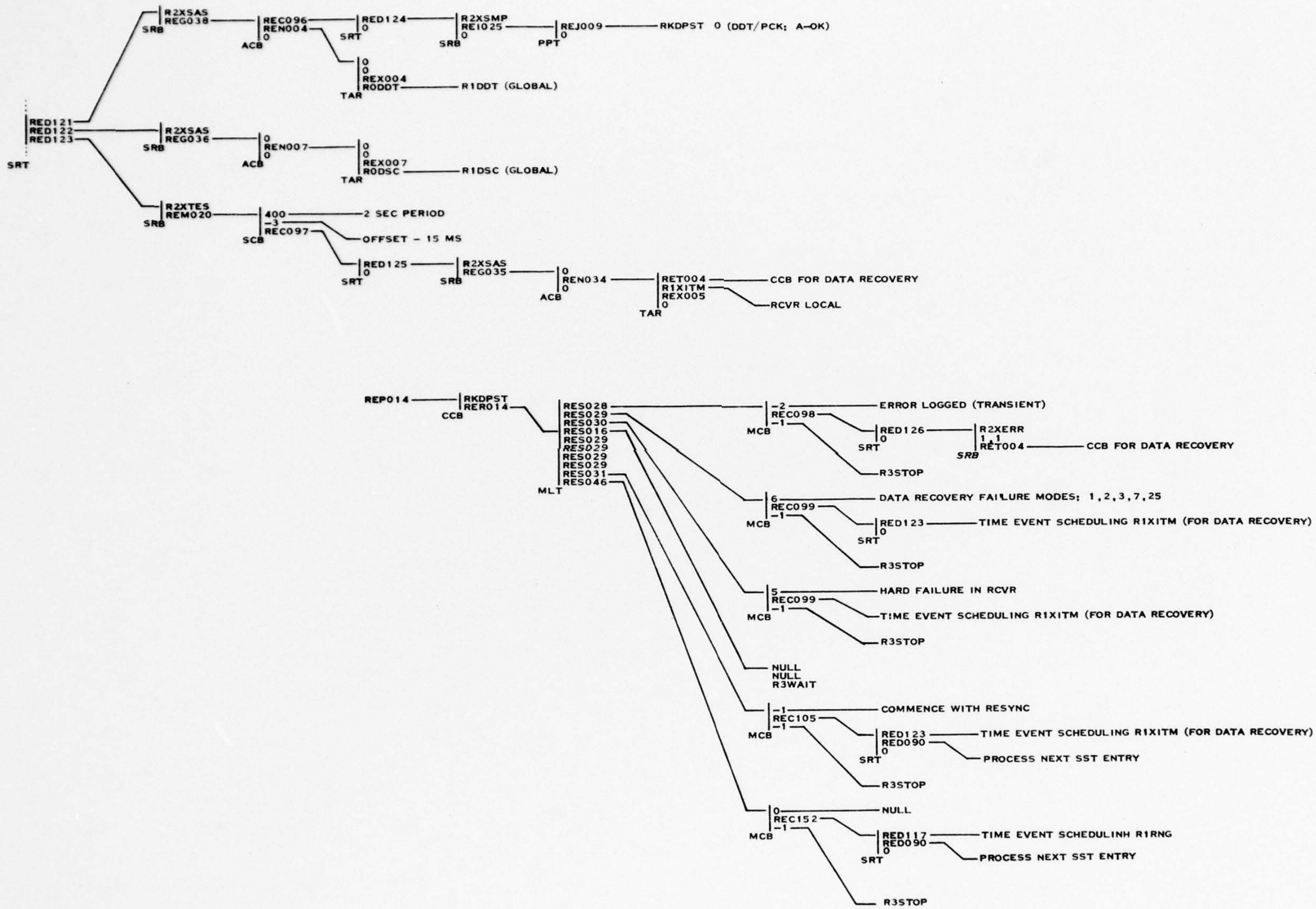


Figure 17. Data Recovery Primitive Sequence

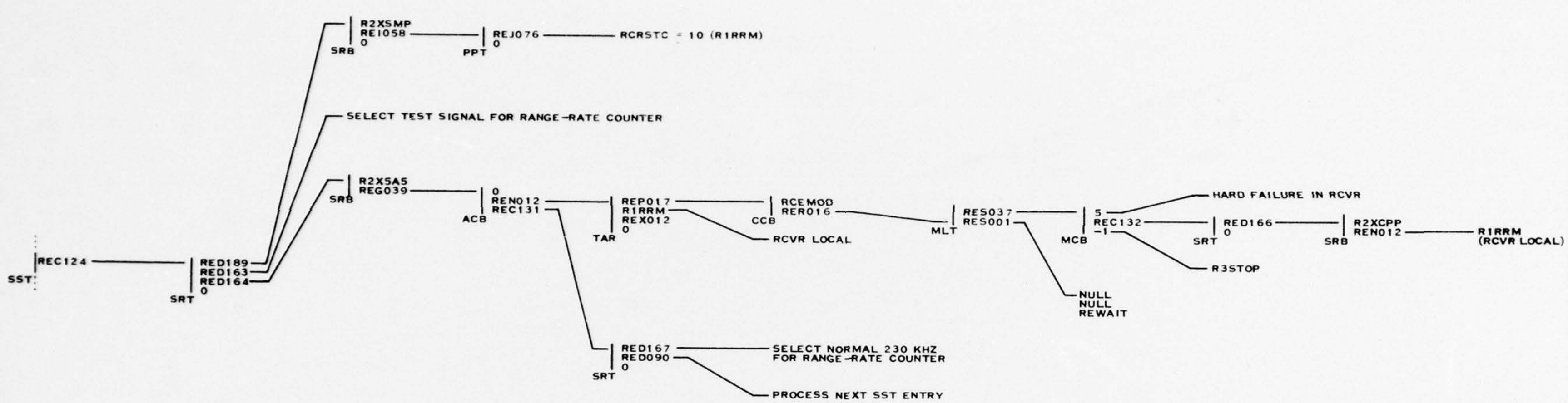


Figure 18. R1RRM Primitive Sequence